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THE WIZARD OF ODDS

He solved a telephone traffic problem two centuries ago

Jacques Bernoulli, the great Swiss mathematician, pondered a question early in the 18th century. Can you mathematically predict what will happen when events of chance take place, as in throwing dice?

His answer was the classical Bernoulli binomial distribution—a basic formula in the mathematics of probability (published in 1713). The laws of probability say, for instance, that if you roll 150 icosahedrons (the 20-faced solid shown above), 15 or more of them will come to rest with side "A" on top only about once in a hundred times.

Identical laws of probability govern the calls coming into your local Bell Telephone exchange. Suppose you are one of a group of 150 telephone subscribers, each of whom makes a three-minute call during the busiest hour of the day. Since three minutes is one-twentieth of an hour, the probability that you or any other subscriber will be busy is 1 in 20, the same as the probability that side "A" of an icosahedron will be on top. The odds against 15 or more of you talking at once are again about 100 to 1. Thus it would be extravagant to supply your group with 150 trunk circuits when 15 are sufficient for good service.

Telephone engineers discovered at the turn of the century that telephone users obey Bernoulli's formula. At Bell Telephone Laboratories, mathematicians have developed the mathematics of probability into a tool of tremendous economic value. All over the Bell System, the mathematical approach helps provide the world's finest telephone service using the least possible equipment. The achievements of these mathematicians again illustrate how Bell Laboratories works to improve your telephone service.

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World center of communications research and development

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Education for Expanding Horizons in Electric Power

G. S. BROWN
FELLOW AIEE

Because of the rapidly changing nature of technology, today's approach to engineering education is more toward fundamental principles and less toward contemporary practice. In order to communicate fluently with tomorrow's graduate, industry must keep abreast of these changes in engineering curricula.

AS I LOOK BACK upon the undergraduate education of those who were of my generation in college, I can see evidence that the doctrine of engineering education was that what a young man learned in an engineering curriculum would serve him throughout most of his professional lifetime. Many professors of about that time had a relatively firm idea of what their students needed to know by way of art and practical know-how in order to have careers in the professional world they were about to enter. This looked appropriate for, after all, these professors had, in no small degree, conceived most of the world of electrical technology of about that era. It looked very sophisticated and enduring. They accepted the principle that it was proper for a curriculum to be largely based on contemporary practice, because they assumed that the engineering profession would merely build the mechanisms of society, often to a conventional pattern, and keep them running. This doctrine stemmed from the assumption that technology would not change appreciably during an engineer's professional career.

But today the problem for the engineering-degree-granting college is different. The last two or more decades have witnessed great productivity in science with the uncovering of tremendous amounts of wholly new knowledge about the physical world. We see everywhere around us a turbulent technological scene. Engineering proliferates with accelerating tempo into many fields, each with a broad range of work function, each undergoing rapid technological change. The changing face of technology presents educators with an ever-widening spectrum of problems. With each successive commencement exercise, it becomes increasingly difficult and increasingly unwise to equip graduates with specialized know-how skills related to contemporary engineering practice. Not only will tomorrow's engineer need to know more than his counterpart of a few decades ago, but he needs to be prepared to learn more during his professional lifetime than was anticipated a few decades ago. And what he must learn will often be quite different from what he was taught in college.

Within the young and rapidly changing field of electrical engineering, we encounter a wide variety of work functions. The majority of the graduates work for industry and not for a client. Matters of public safety, of equipment cost, and so forth, are important, but the yardstick by which their importance is measured is a function of who is the customer. Where the customer is a branch of the military, and he very often is, the yardstick for performance and cost of devices and systems is often calibrated in terms of national survival rather than by a 6% return on investment. Change is often encouraged for change's sake. Modern science exerts a dominant role in all engineering, and especially in defense engineering. Much engineering is done prior to a demonstration of practical feasibility.

The contrast in criteria that set engineering values in the design of (a) a multimegawatt generating station for a public utility and (b) a multikilowatt generating plant for a large vehicle to operate in outer space, puts the picture into focus. The former system may be typified as stationary—coal-, oil-, or gas-burning—for a uniform environment, requiring 100% reliability, low capital cost, and low maintenance. Each new plant must be superior to its predecessor because of a number of circumstances, but it comes into existence largely through an orderly integration and some extension of the known art of the day. The latter system, however, in all probability must have negligible weight and size, use electromagnetic radiation as its source of energy, withstand large accelerations, and operate for limited time in environments never encountered by man. Furthermore, its design must be compatible with the changing needs of many interlocking requirements set by specialists in navigation, guidance, aerodynamics, and so forth. The engineers who are to create this system encounter many problems for which there is little prior art to supply many of the answers. They must lean heavily on fundamentals of science and on their ability to apply them.

We are now witnessing the gradual substitution of fission fuel for fossil fuel, with its attendant highly technical problem of protection of personnel and equipment against radiation. The future shows promise of wholly new techniques for converting heat into electric energy. Thermoelectric power conversion by thermopiles using advanced semiconductor technology, or ther-

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mionic generators on a grandiose scale, or fuel cells as chemical–electric converters, or thermofusion energy, are live topics on today's engineering campuses. Digital computers of amazing capability are taking over jobs that engineers once performed by hand. They and many other technological developments are having a vast impact on the jobs that engineers perform, on the work function of vast categories of professional men.

THE ACADEMIC SCENE

THE ACADEMIC ENVIRONMENTS in engineering differ markedly throughout the land and markedly even within the broad field of engineering. Some institutions are oriented toward research, others toward applied engineering or manufacturing, to cite merely a few. The big differences in the work function among different fields of engineering, and even within fields, exert considerable influence on educational policy.

As engineering as a vocation and as a profession has evolved, we have devised a system of 2- to 3-year technical institutes, 4- to 5-year baccalaureate-degree-granting engineering colleges, a system for on-the-job education of graduate engineers in industry, and an expanding program of graduate education in engineering colleges. The doctor's degree is becoming a prerequisite for leadership in many engineering areas.

Since it appears certain that we will adhere to the 4-year program of undergraduate education in engineering in most colleges and universities for quite a while, engineering curricula are allocating less time to a treatment of contemporary engineering practice and more time to broad basic science and to the engineering of science.[1-3] As professors concern themselves with this limited task while continuing to point their interests toward engineering, they find the available time for undergraduate education much too short for the job that industry and society expect of them. On all sides we are witnessing a reassessment of the content of curricula and the methodology for giving an enduring, purposeful education to our future engineers.

The problem before engineering educators is that of being sensitive to the expanding body of scientific knowledge and to the wide spectrum of work function in industry. Educators must continually update the scientific or technical content of their program of instruction. Likewise, industrial leaders must keep abreast of the changes that occur in college environments as year by year the professors' interests change with the unfolding of new knowledge, and as curricula, in updating, become more broadly based in the sciences. The updating no longer can be achieved merely by adding new material to an existing curriculum. The problem is not what to add but what to drop in order to make room for change. Often the procedure is misunderstood, as evidenced by the comment of a British educator who visited my office a few months ago. He was about to return home, and the observation that bothered him most was that the teaching of electric power engineering had about disappeared from the American campus. Everything is electronics, he said. What he had not observed was that everything electrical is a manifestation of charge carriers, that a broadly based program called electronics can embrace power or, more properly, electric energy processing; and that electric power itself is emerging in new, more modern forms.

It appears to me, therefore, that the solution at the undergraduate level is continually to bring about fresh course syntheses that have wider applicability within the criterion of "knowledge that will be negotiable at par in many allied fields for a reasonably long time." Specialization is being moved to the graduate level. However, the guideposts for doing this are varied and often appear contradictory.

GUIDEPOSTS TO AN ENGINEERING CURRICULUM

IT IS WIDELY ACCEPTED that engineering is the exploitation of science for the betterment of man. In other words, doing engineering is applying science or practicing the quantitative organization of natural phenomena. But in its creative aspects it comprises the ability to relate seemingly unrelated events of nature in quantitative ways in devising useful configurations of matter, elements, devices, or systems. It must also quantitatively classify the recorded observations of science in ways that will provide a prediction of quality and quantity of the outcome of designs not yet concluded,[4] in order that the extent of our achievements shall be encouraged to grow from seeds of suggestions and that the possibility of new applications shall be enhanced and the validity of theories extended to include a continually widening scope. In summary, one can say that doing engineering is practicing the art of the organized forcing of technological change.

It should be recognized that not all persons who should undertake a career in engineering are endowed with identical talents. Because of the wide diversity among people and the wide diversity of activity within engineering and the limited scope of most engineers' activities, it is helpful to classify broadly the work functions of engineers. In actuality, there are about as many work functions as there are people, but to point up some meaningful aspects of activity in relation to education, I shall take the liberty of classifying the doing of engineering under three categories, knowing perfectly well that the specific kinds of competence we seek are a blend of what an engineer has as natural gifts, what he learns in college, what he learns on the job, or just by living longer and observing the world around him. Subject, then, to this oversimplification, I submit that we can identify broadly three categories of work function.

Category A—A person who has the talent for detecting deficiencies in the capabilities of existing engineering devices or systems, and who can conceive from abstractions or from the whole body of science, wholly new superior devices and systems. This man can relate quite abstract and seemingly unrelated concepts in useful ways. He is a composer rather than an arranger. His work is predominantly intellectual and varied. These

are the engineers who, for example, having perceived the need for increased capability in computation, can conceive and point the way to the giant digital machines long before the first one is built; or who, from an assessment of the dwindling fossil fuel supply, perceive the possibility of, and point the way to, nuclear power or the direct conversion of cheap heat into usable electricity by thermoelectric generators, or who can synthesize from abstract science the techniques by which man may tame the energy of thermofusion. The power industry needs these men within its fold.

Category B—A person who can devise and build systems of engineering works by an orderly, creative, ingenious arrangement of the known knowledge of the day. This man is more the creative arranger or inventor than the composer. He works at a less abstract level than does category A; he is sensitive in a quantitative way to engineering feasibility, and to economics. He needs a high degree of competence in the areas of mathematics, physics, and related sciences, for he must understand both how and why machines work, and perform complicated analyses. He designs and builds complicated engineering works. In a great many instances, he is doing something new. Within his area of work, he may perform at the same level of creative achievement, but of a different character, than does the engineer in category A. Without this person, the contributions of the engineer of category A would be slow in coming into physical actuality.

Category C—A person who is expert in assembling, operating, and maintaining complicated machines and engineering works from drawings, descriptions, and from experience. These persons are not second-rate citizens. In tomorrow's era of technology they will be needed in great numbers. They find it difficult to move ahead with the stream when they have less than 2 years of study beyond high school. The environment in which they learn, however, can appropriately be pointed at teaching them the "how" in addition to the "why" of contemporary engineering practice, devices, and systems.

For the engineers of either category A or B, the bachelor's degree should be only a beginning. Throughout the professional lifetime of these men, they shall witness great change and shall be required to learn a great deal of technology that was not even visualized during their college career. They are the engineers whose careers are influenced by the fact that never has a machine been devised by man which within a few years has not been called upon to perform at a level of capability greater than its creators built into it. Throughout the whole undergraduate program of these men, emphasis should be to provide a sound training in basic science and in applying the scientific method to the solution of tomorrow's problems and not yesterday's, and to developing those qualities of character and mind typical of a great industrial leader. The curriculum should be pointed toward graduate work; for many it should point toward the doctorate. The environment should be charged with creativity. The knowledge acquired should be intellectually open-ended so that it will be negotiable at par in many fields for a long time to come. On the other hand, I believe that it is appropriate to offer for the engineer in category C a bachelor's degree program in a technical school and to regard it as terminal. His continued education will occur largely on the job.

The relative need for persons in these categories of work function varies in different fields and in different societies. In many societies the person in category C is the most valuable and in most demand. But regardless of where a person gets his education, I believe that he should be given the opportunity to develop to the highest intellectual level that his talents will allow. Unfortunately, our educational system does not find it easy to do this.

SOME SPECIFICS OF ENGINEERING CURRICULA

SPEAKING SPECIFICALLY with respect to technical competence, and perhaps paradoxically, specialized professional competence in the newest fields is secure only when it is built on top of a sound fundamental training in the oldest of our disciplines, namely physics, mathematics, and chemistry. I say "the newest fields" because I emphasize again that within the 40-year professional lifetime that is ahead of today's college student, there will be many changes. Many new fields will emerge and demand their services.[5]

Hence, it is not surprising that in planning engineering curricula, increased emphasis is being given to these old disciplines, and to building on them new syntheses of a body of knowledge called engineering science. These engineering sciences couple the classical scientific subjects with new engineering frontiers. Our new role is to illustrate the *engineering of science*. Indeed, it is this frontier coupling, or interaction in engineering, that we must make clear to students who want to become engineers and not scientists. The teaching of mechanics and dynamics in the broad sense; of thermodynamics and statistical mechanics, mass momentum and heat transfer, electrical science of a kind that treats electric and magnetic field and circuit phenomena at an advanced level as related to energy and information processing; and of microscopic properties of matter in relation to materials in engineering, should be made relevant to tomorrow's engineering. No two colleges, nor for that matter any two departments of the same school, are approaching the future in the identical way. This seems proper in view of the wide differences among engineering fields and among academic environments. But the trend toward engineering science[3] in lieu of specialization, for an undergraduate degree, has been with us long enough to indicate that we may be beyond the point of no return.

As the increased relative importance of engineering science has stimulated college faculties to remake their course structures, there has been widespread searching for guideposts. Initially, the reassessment is limited to studies within departments; however, pressures to do this on interdepartmental and interdisciplinary bases

are increasing. There are many educators who question the wisdom of preserving an undergraduate program that is organized along conventional lines of electrical, mechanical, chemical, aeronautical, metallurgical engineering, and so forth. The careers of many engineers prove to be no respecters of such categorizations.[5] The existence of large digital computers as commonplace engineering tools has had a major influence on what engineers now do.[6] The boundaries between our established departments on academic campuses are becoming more permeable, but professional society structures, ECPD (Engineers' Council for Professional Development) accreditation practices,[7] licensing practices for engineers, and so forth, are so well entrenched and such important parts of our heritage, that change is going to be evolutionary rather than revolutionary.

The criterion that "the knowledge should be negotiable at par in a wide range of allied fields for a significant period of time" should be a dominant factor in establishing guideposts. For an electrical engineer, another guidepost is that everything characterized as electrical is a manifestation of the phenomena of charge carriers, their associated fields, and how they interact with materials. To inject purpose into a program of study, it is helpful to say that electrical engineers exploit this nucleus or model of natural phenomena to perform useful functions in everyday living, either to process energy for energy's sake, or to process information so that humans can communicate. The processing of energy relates to man's desire to substitute machine for human muscle by providing the giant motors, machines, and power systems that control the wheels of industry and also give us light and heat. The processing of information embraces techniques for establishing communications between man and man, between man and machine, and between machine and machine. Radar, radio, wire telephony, measurement, electronics, computation, and control are the fields where information processing is applied. First-rate competence in engineering practice is made more secure when an engineer is quite knowledgeable in both broad areas. The aforementioned concept of electrical technology is being implemented by curricula and teaching programs in the American colleges in several forms. Behind the names of courses, one can observe emphasis on such open-ended topics and concepts as electric circuit theory; electronic devices and circuits; information-handling systems; electromagnetic theory; electric energy conversion, transmission, and radiation; and modern physics and materials.

In many colleges, the sophomore and junior year work is substantially science and electrical science. In the final year, students take various electives that couple the earlier study with areas of application. Here, hopefully, they come to grips with some of the new engineering frontiers.

Speaking strictly about my own institution, we have abandoned an option structure that was attempting to provide specialization by field such as power, communications, computation, radar, and so on; and we are veering toward an option structure that is showing signs of compatibility with the categories of work function given here as A and B, for they exist throughout all fields. We have had our co-operative course in electrical engineering, course VI-A, as one option for about 25 years. Recently we initiated an electrical science and engineering option, course VI-B. The latter option is intended to provide the maximum opportunity for early development of the person whose eventual academic level is the doctorate and whose eventual work function would fit category A. Our program in courses VI and VI-A fit students who may be oriented toward either category A or category B.

In the evolution of this program, new areas of instruction have come into being. New laboratory facilities have been evolved. A graduate of the department a decade or so ago will recognize in today's program little of what he studied, but we hope he will feel that he now sees what he wishes he had studied. This is especially true of the graduate who has made his career in the electric power field. Alumni and educators from industry who know of the program in detail have given it a vote of confidence.

THE COUPLING OF INDUSTRY AND EDUCATION

As technology has advanced during the last decade, the newer fields have often appeared more glamorous than the older ones. For perfectly valid reasons, the research interests of engineering professors are in the newer fields. In fact, many of these fields were spawned by these research interests. As a consequence, the communications links between the older and well-established fields and the new challenging activities on college campuses often become strained. In many instances, they have become disconnected.

This situation is not good. The field of power generation in the public utility area, while long established, continues to enlarge. It needs to recruit able young men to take care of growth, to stimulate its technological advance, and to replace the engineers who, after long years of productive service, have reached retirement. It needs its proportionate share of first-rate minds in both category A and category B.

My evaluation of the situation is that ways must be found to restore this communication link. I venture the opinion that restoration will be done best by activating open-ended on-campus research in energy processing and related areas, rather than merely in electric power, in ways that capture the interest of both engineers in industry and engineering college professors.

I do not think it advisable to establish research on engineering campuses around topics that relate to contemporary industrial practice. Faculty research is of questionable academic caliber unless it is basic, open-ended, and has a lead time with respect to its effect on industry of several years. I believe that some new horizons need to be explored and I think we are about to enter the period when we can initiate them.

For example, throughout all industry a major deterrent to advancement is the limited capability of exist-

ing materials. Basic research in the area of molecular engineering to achieve new materials and improvements in existing materials would be most fruitful.

Within the broad field of the direct conversion of heat into electric energy, there are many problems whose solution would yield useful engineering developments within 5 to 10 years. Specifically, the exploitation of solid-state technology, plasma dynamics, and magnetohydrodynamics to provide new machines to furnish electric power are good examples. The research activity in these areas should be flexible and imaginative, for it is not possible for any person living today to visualize what technology of 10 years hence has to offer. It is clear from the record that the future will be different, that it will surprise us, and that the public utility industry will need what it brings.

The advent of the large digital computer[6] opens up a wide vista for gainful research in the power area. Automatic monitoring of load generation and distribution presents a challenge. Contemporary digital computers possess a capability that so vastly exceeds the capability of network analyzers of merely a decade ago that the methods for representing complete electric generating systems on computers for stability and power-flow problems merit reassessment. It is no longer necessary to use over-simplified mathematical models of boilers, turbines, speed governors, generators, and voltage regulators.

As technologies for the direct conversion of heat into d-c energy reach the engineering phase, there will be need for the invention and engineering of new machines to utilize energy in the form of kiloamperes at a few volts, in contrast with a few amperes at high voltage as we use it today. There is need to devise ingenious ways to convert big blocks of energy from direct current to alternating current, perhaps by devising ingenious ways to exploit modern silicon diodes and modern switching transistors. We now need better and cheaper ways to convert from alternating to direct energy.

The long-term values of on-campus research in which a student participates need wider recognition. This does not imply that a student is being trained only for a job in research and development. Rather, it is to enhance the probability of developing his talents of creativity and versatility or originality. Even if he does head for research and development, he may be making a wise choice, for, increasingly, management leaders are being selected from personnel within this category of work function.

The electric utility industry has yet to find a way to allocate funds to college professors for research of a professor's own choosing that is compatible with an academic career. The older procedure of contracting with colleges for programmatic work that is more engineering than research, and monitoring it from the central office, does not meet with the enthusiasm necessary.

CONCLUSION

THE PERSISTENT SUBSTITUTION of machine for human muscle forecasts continuing programs to construct electric generating and distribution plants to keep ahead of demand. With increased load comes a demand for increased size of plant with increased performance. Increased numbers of engineers are required to build bigger and better plants on a shortened time scale and to incorporate new technological developments. Concurrent with these trends is an exfoliation of engineering into many new highly technical challenging fields that compete for engineers.

These situations tax the technical and administrative skills of the practicing engineer and of the professor who is to educate tomorrow's engineer. Since engineering colleges are restricted, in the main, to the 4-year undergraduate program, they are adjusting to the challenge by presenting students a more integrated body of fundamental knowledge, at the sacrifice of the specialized knowledge characteristic of the past. Many graduates of a modern 4-year curriculum are capable of a career in any one of several industries. When an employer first talks with a recent 4-year graduate, he is less likely to find a specialist ready for his industry than did his predecessor a decade or so ago. This is especially true of employers in the electric power industry.

Industry needs to keep abreast of the changing technical content of modern engineering curricula, and of the changing educational environment in order to communicate fluently with tomorrow's graduate. It needs to appreciate the vital role of on-campus research and graduate study in keeping our educational institutions places of learning, rather than merely places for teaching. The importance of recruiting top-flight young minds into all segments of industry on a balanced basis needs attention. The importance of aiding practicing engineers to obtain refresher instruction in an organized manner every 5 years or so is increasing. The key to the much-needed communications between the leaders in the electric power industry and the professors on engineering college campuses is to initiate more open-ended programs of on-campus research under direct industry sponsorship.

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Life Characteristics of Carbon-Film Resistors

H. M. BRANER

J. L. EASTERDAY

THE DEVELOPMENT of carbon-film resistors since World War II has provided the electronics industry with a reasonably priced semiprecision resistor. Considerable effort has been devoted to determining the quality of these resistors, and minimum standards, such as those in Specification MIL-R-10509, have been established.

Under the sponsorship of the U. S. Signal Corps Research and Development Laboratory, Battelle Memorial Institute embarked upon a program designed to investigate the stability of carbon-film resistors when operated at rated load in an ambient temperature of 70 C for 12,000 hours. The carbon-film resistor types investigated were ½-watt 237,000-ohm (critical value) resistors and ½-watt 100,000-ohm borocarbon resistors, with a nominal tolerance of ± 1%. Four brands for resistors were included, of which three were deposited-carbon-film type and the fourth a borocarbon-film type. The case types represented were molded and ceramic tube. The evaluation of these resistors was based on sample sizes of 250 or 500 for each brand.

The data-recording and measuring equipment used in the study was completely automatic. Battelle designed and built an automatic scanning device which selects the components in the temperature chambers in a specified order and connects each to a Barnes deviation bridge. The percentage of resistance deviation from a standard as measured by the bridge, resistor identification, and fixed identification are automatically punched on cards at a rate of 1,400 readings per hour.

The data are presented in two types of graphs. The first of these, Fig. 1, shows the percentage of the sample over time which exceeded some arbitrary failure criterion; 2% in this case. The second type of presentation is in the form of cumulative probability distributions of resistance deviations from initial at some specified time. Fig. 2 is this type of chart, showing resistance deviations from initial values at approximately 12,000 hours for each of the four varieties of resistors investigated. The upper 95% confidence limit on the observed per cent of resistors exceeding the deviation shown is presented at the right-hand ordinate.

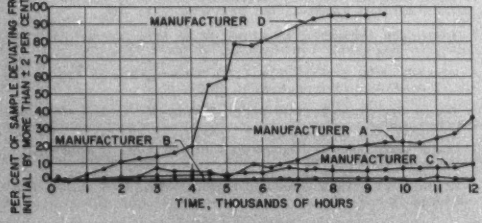
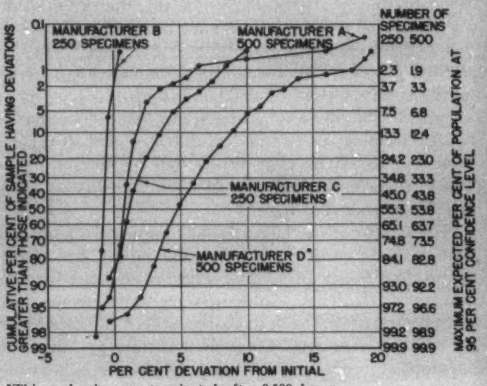

PER CENT OF SAMPLE DEVIATING FROM INITIAL BY MORE THAN ± 2 PER CENT
MANUFACTURER D
MANUFACTURER B
MANUFACTURER A
MANUFACTURER C
TIME, THOUSANDS OF HOURS

Fig. 1. Load-life characteristics of deposited-film resistors.



*This evaluation was terminated after 9,500 hours.

Fig. 2. Cumulative probability distribution for deposited-film resistors after 12,000 hours of load life.

Using a 2% resistance deviation from initial as an arbitrary failure criterion, it was found that the carbon-film resistors of manufacturers *A*, *B*, and *C* have average failure rates ranging from about 0.13 to 2.3% per 1,000 hours. In addition, some types of carbon-film resistors exhibited a number of catastrophic failures and case defects, similar to crazing, on the outer surface.

The borocarbon-film resistors of manufacturer *D* experienced an average failure rate (using the 2% criterion) of about 10% per 1,000 hours. Thus, by 9,500 hours, most of these resistors had "failed," and over 50% of them had resistance deviations exceeding 5%.

The results indicate that the carbon-film and borocarbon-film resistors investigated in this program will not meet long-life high-stability requirements at 70 C. The unsatisfactory characteristics of these resistors after long periods of operation are (1) a larger number of failures, (2) excessive resistance deviations, and (3) case cracking. A number of individual specimens evaluated did display the desired properties, and it is thought that further development of resistor cases and greater control over film properties during manufacture would result in a fixed resistor with superior life characteristics.

Digest of paper 59-36, "Life Characteristics of Carbon-Film Resistors after 12,000 Hours of Operation," recommended by the AIEE Electronics Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, New York, N. Y., Feb. 1-6, 1959. Published in AIEE *Communication and Electronics*, May 1959, pp. 201-07.

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Precision Integrator for D-C Potentials

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MEMBER AIEE

INTEGRATORS of small direct currents and potentials are useful in a variety of applications such as measuring photographic exposure with photovoltaic cells, registering watt-hours derived from the d-c output of watt converters, both thermal and electronic, and integrating current consumption in electroplating.

An integrator is described which utilizes a d-c amplifier and a motor-driven tachometer d-c generator providing feedback potential as principal elements. The input circuit is free of make-and-break contacts, and the amplifier gain is very high, so that an accuracy of 0.1% is regularly achieved and potentials as low as 5 microvolts are resolved. Potentials may be of either polarity. Values of the integral are almost continuously registered by a counter driven by the motor, and values increase or decrease according to the polarity of the input. Fig. 1 is the circuit diagram.

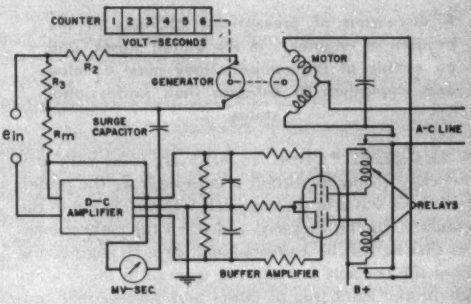

Fig. 1. Schematic diagram.

The integrating process consists of amplifying the difference between the input potential and the emf (electromotive force) derived from the small generator. The amplified difference controls the operation of the servo motor coupled to the generator. A fixed quantity of millivolt-seconds is generated at every revolution. When the generated millivolt-seconds are fed back in opposition to the input millivolt-seconds, the two sooner or later come into balance, because any remaining difference appears as voltage across the surge capacitor which causes the motor generator to rotate.

Output current from the d-c amplifier flows through R_m, which is a mutual feedback resistance between input and output. When the generator is stationary, surge capacitor potential being low, the resulting potential drop across R_m substantially balances e_{in} while the current charges C. Voltage builds up across it until it operates a motor-control relay through the buffer amplifier. This causes the motor–generator to rotate and deliver an emf across R_3 which is higher than the 70-millivolt average input potential permitted by design. Then the net potential input at the amplifier is reversed, the output current reverses, and the surge capacitor is gradually discharged. At about 2 volts, the contacts are closed and the motor stops.

The d-c amplifier is a highly stable type utilizing an induction galvanometer to convert input currents to high-frequency alternating current. This causes frequency modulation of an oscillator, the output of which is converted to bidirectional direct current by a discriminator. This amplifier is primarily responsible for the high accuracy and resolution achieved by the integrator. Accuracy is not materially affected by amplifier gain, nor by the magnitude of the mutual resistor or surge capacitor.

Accuracy also depends on the performance of the generator. A high-quality tachometer generator is employed, which has a field magnet of cobalt steel, and brushes and commutator of silver. Compensation is provided for the negative temperature coefficient of the magnet by connecting a voltage divider across the generator output. The shunt branch R_3 has a section of copper wire, the positive temperature coefficient of which provides the compensation. A steel shield encloses the generator, which has a cast aluminum case completely enclosing the magnet, armature, and resistors. Internal power dissipation is only 800 microwatts and the speed is about 45 rpm, so that self-heating is negligible. Under these conditions, uniform internal temperature is maintained and the magnet is shielded from stray fields.

The integrating action of the counter is intermittent, but it does not lag the true value by more than 15 millivolt-seconds. When integral steps smaller than this must be resolved, a voltmeter is added which measures the analog voltage of the surge capacitor. This is the instrument labeled MV-SEC in Fig. 1, which indicates the residual integral not transferred to the counter. With its help, integral values can be resolved to 1 millivolt-second.

An integrator is described for time-integrating direct potentials of either polarity up to 70 millivolts average value with a resolving power of 5 microvolts. Currents can be integrated by means of shunts, and power by means of watt converters. Integral values are registered with an accuracy of 0.1% or 1 millivolt-second, whichever is greater.

Digest of paper 59-166, recommended by the AIEE Indicating and Integrating Instruments Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, New York, N. Y., Feb. 1-6, 1959. Published in AIEE *Communication and Electronics*, Sept. 1959, pp. 450-53.

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Professionalism and the Individual Engineer

EDWIN FLEISCHMANN
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A discussion of present-day changes in the position of engineers in the United States, and an outline of the attitudes they must develop and strengthen to enhance their professional status.

CURRENT PUBLICATIONS are filled with articles on how important it is to improve the professional status of the engineer. We must begin in the secondary schools, they say, and teach the embryo-engineer that he will be a professional man. In engineering school the teachers are adjured to impress the student with proper standards of ethics and professional conduct. Just what, basically, is the implication of this? In short, if we are to develop engineers as professionals, it will first be necessary to know what we expect to achieve. Dr. W. E. Wickenden, a former president of the AIEE has asked and answered the question as follows:

> "What marks off the life of an individual as a professional? First, I think we may say that it is a *type of activity* which is marked by high individual responsibility and which deals with problems on a distinctly intellectual plane. Second, we may say that it is a *motive of service* as distinct from profit. Third, is the *motive of self-expression*, which implies a joy and pride in one's work and a self-imposed standard of workmanship—one's best. And fourth, is a *conscious recognition of social duty* to be accomplished, among other means, by guarding the standards and ideals of one's profession and advancing it in public understanding and esteem by showing advances in professional knowledge and by rendering gratuitous public service, in addition to that for ordinary compensation, as a return to society for special advantages of education and status."[1]

Many engineers look wistfully at lawyers and doctors, and say to themselves that those are the real professions. Why can't we be like that? There are, of course, two important reasons:

1. No one in a civilized society can go through life without at some time needing the services of a doctor, and very few can avoid situations which call for expert legal advice. Most people, on the other hand, never need to call directly on an engineer. While they may be conscious of engineering through their use of technical products, the personal contact is missing. They have no first-hand experience of seeing what the specialized skill of the engineer can do for them when they are in trouble.

2. Because most engineers work for someone else, they have only one client, and are, therefore, more dependent upon him alone for their livelihood. Such a situation is bound to lead to some cramping of the individual's independence of viewpoint or analysis, however hard he and his employer may try to avoid it. True, he may quit and get another job; but this may be a major project, impossible or impracticable under the circumstances. On the other hand, doctors have numerous patients, and lawyers have many clients. If the independent judgment thus exercised by the practitioner does not please one patient or client, there are others who find it satisfactory.

The first of the distinctions mentioned importantly narrows the market for engineering services. The second one alters considerably the type of standards which the engineer may hope to set for his profession.

How important the latter has become is evident from a look at the statistics. Though only meager data are available, there is an indication[2] that not more than 5% of all the engineers in the United States are self-employed, and for electrical engineers, the percentage is even smaller. The 1954 Employment Questionnaire of the AIEE showed that only 3.4% of the members at that time were self-employed.[3] Similarly, in March 1956, the Eta Kappa Nu Association, AIEE, Institute of Radio Engineers (IRE), and Stanford Research Institute surveyed the seniors and graduate electrical engineering students in 129 colleges. Although substantial proportions of the 3,433 individuals interviewed felt that both the technical and financial opportunities in "Engineering or Consulting Service" were "good" and an even larger percentage felt they were "average," only 3% of the students who had accepted jobs in March had chosen those fields.[4]

STANDARDS TAILORED TO SPECIAL CONDITIONS

PRESUMABLY, then, 97% of all electrical engineers work for someone else. It is, therefore, of the greatest importance that engineering standards of professional conduct be tailored to fit this situation, which is unique among the learned professions. They must be formulated by engineers themselves with a full awareness of the implications of their actions, and uninfluenced by immediate swings in the availability of engineering graduates.

Time was when there was a surfeit of engineers. Industrial managers, who exercised the greatest care in the selection of a lawyer to handle an important case,

A special article recommended by the AIEE Professional Conduct Committee.

Edwin Fleischmann is a consulting engineer in San Francisco, Calif.

or a doctor for serious illness, hired engineers with a certain abandon. The statement was that engineers were a dime a dozen; they don't know much when we get them; but we teach them what we want them to know.

Too much of the literature on the subject of engineering education has stressed the need to train engineers for industry, to make them into neat cogs which will fit into the industrial machine without any friction whatever. How can this sort of instruction turn out truly professional men? If our engineering schools are merely to mold future engineers so they will exactly suit a given niche in industry, almost none of Dr. Wickenden's qualifications will be met.

MORE FAVORABLE SITUATION

Today the situation has changed completely. During the past several years, we have witnessed a growing shortage of engineers in the United States. Older men have been retiring and the graduating classes in our engineering schools have been shrinking alarmingly. Business circles have called attention to the need for expanding our ranks,[5] but unfortunately the efforts of managements to woo engineering graduates have followed the earlier philosophy of offering only such inducements as more money, or better working conditions, or more favorable pension plans. All too seldom do the lures held out to young engineers—or older ones—involve improved professional status as well.

Thus, the time has come to make a change. Let us start to train industry for engineers, to insist that industrial employers: (1) utilize engineers as individuals with individual responsibilities; (2) permit them to utilize their special skills in the solution of problems on a distinctly intellectual plane; (3) realize that the "motive of service as distinct from profit" does not justify exploitation of the engineer for the sole benefit and profit of the employer; (4) allow the engineer a broad range of self-expression which is a most important ingredient in arriving at independent judgements; (5) not cavil at the sense of perfectionism, which is inherent in an adequate "self-imposed standard of workmanship"; (6) encourage the engineer's attitude of willingness to serve his community, even if such service may not be wholly productive of benefits to the employer; and (7) stimulate engineers to broaden their interests in other fields as well as their specialties by study, and by attendance at and participation in meetings and activities of their professional societies.

PROFESSIONAL ATTITUDE NECESSARY

Basically, no such reshaping of industry's attitude toward engineers will be possible without some widespread changes in the attitude of engineers themselves toward their profession, coupled with a willingness to do something about their own personal professional stature. It will be necessary for them to adopt a truly professional posture toward their work in every way. Many may find this difficult; others may already be following such policies in their daily contacts. Among the important professional attitudes which the present shortage of engineers makes possible are the following:

1. Decline to be swayed from a method or course of action believed to be correct, in order to arrive at a result which, on the basis of engineering training and experience seems improper. This refusal may have to be implemented by a willingness to quit his job if the engineer's principal insists on having him do what he considers technically wrong.

2. Make sure sufficient technicians are available so that engineering time and effort are not wasted in routine paper work, computations or drafting which can be better and more economically done by others.

3. Insist on a position of such independence in the organization that the solution of given problems can be based on individual skill and judgment rather than on some preconceived notion of what the answer ought to be.

4. Recognize that, if engineering is a profession, it must be practiced by individuals, whether self-employed or not. As Dr. Wickenden says, a profession "is marked by high individual responsibility." Corporate practice of engineering utilizes the corporation as a device for avoidance of individual responsibility. This is the very antithesis of professionalism and should be discouraged.

As technical organizations grow larger, the individual engineer may get farther and farther away from his principal. His contribution to the engineering excellence of his company often becomes part of a mass rating technique. He may tend to become just another cog in the machine. The literature is replete with suggestions for rating engineers in large groups. A recent suggestion[6] describes a technique used by Bell Telephone Laboratories. The aim of all such schemes is to remove the personal element, the individual judgment, and reduce everything to cold statistical analysis. A true professional activity is not susceptible to such evaluation.

5. Take the position that engineers are individual advisors to management, and as such, need no intermediary like a union to bargain for them with the management on salaries or working conditions which are, in essence, comparable to the individual practitioner's professional fees.

For the present status of professional recognition, or lack of it, engineers have themselves to blame. Improvement of their situation rests with them, too. It is a number one "do-it-ourselves" project.

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Barge-Mounted 15,000-Kw Gas Turbine–Generator Plant

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MEMBER AIEE

P. R. BEARD
ASSOCIATE MEMBER AIEE

Because of economic and operational considerations, it was decided to depart from steam generation in making the latest addition to the Punta Gorda steam electric plant at Lake Maracaibo, Venezuela. Barge mounting of the gas turbine unit utilized provides mobility and flexibility.

Fig. 1. General view of 15,000-kw floating gas turbine–generator power plant. Electric equipment and control house are in the bow, shown at the right.

THE FIRST of two 15,000-kw gas-turbine-driven floating power plants was recently placed in service by the Creole Petroleum Corporation at Lake Maracaibo, Venezuela. Each unit is a completely self-contained power plant mounted on a steel barge 50 by 200 feet (Fig. 1). In addition to the turbine–generator, the barge contains the required oil and gas fuel handling equipment, step-up transformers, switchgear, control equipment, and an overhead dead-end structure for connecting the 34.5-kv output to shore. The dual fuel gas turbine may be started, stopped, and controlled either from the control room aboard the barge or from a remote control point by supervisory control.

Although normally anchored in a shallow basin outside of Creole's central power plant at Punta Gorda, the unit may be relocated anywhere in Lake Maracaibo on short notice to provide electric power in an emergency.

The gas turbine is the first unit of this size installed aboard ship. It was built at Avondale Marineways under contract with International General Electric Company in accordance with Creole's guidance specifications. Detailed engineering was performed by Sverdrup and Parcel, Inc., and Avondale Marineways.

Essentially full text of paper CP59-1033, presented at the AIEE Petroleum Industry Conference, Long Beach, Calif., Aug. 23-26, 1959. Recommended for publication by the AIEE Petroleum Industry Committee.

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DESCRIPTION OF UNIT

Barge Hull and Superstructure. All equipment is mounted above deck on a nonpropelled all-welded steel barge 200 feet long by 50 feet wide by 13 feet deep, with a draft of 4½ feet and a superstructure not exceeding 50 feet above water. The unit is designed for operation under rather severe atmospheric conditions, such as winds up to 70 miles per hour, waves 6 to 8 feet high at 100-foot intervals, and tropical temperature and humidity conditions. Under such conditions, it is expected that the barge will not exceed its design maximum of 5 degrees pitch and 15 degrees roll while floating free and unanchored. Properly anchored, the pitch will be reduced to 3 degrees and the roll to 10 degrees.

To prevent capsizing, the barge is compartmented with airtight bulkheads so that fully equipped it will maintain stability with the loss of any two of its 15 compartments. The hull is classified by the American Bureau of Shipping for short coastwise service.

For corrosion protection, the interior of the barge is painted with a semisolid petrolatum-base rust preventative pigmented with pure metallic zinc. This slushing compound is a grease-like material, resistant to displacement from pressure against the coated surface. Its outer surface slowly hardens, while underneath, the film retains its original consistency and self-healing properties. The exterior of the barge hull is given a zinc primer followed by four coats of marine-type vinyl paint. In addition, magnesium anodes are used around the barge periphery for added corrosion protection.

The equipment on the barge (Fig. 2) may be grouped into three main categories:

1. The gas turbine–generator and its auxiliaries.
2. The fuel-handling system, on the input side of the turbine.
3. The electric system, on the output side of the generator.

In addition to the three major equipment groups, there are such other facilities as an air-conditioned control room, a diesel generator for standby electric power, electric hoists for heavy equipment, fire protection and marine safety equipment, and convenience facilities.

The turbine–generator and many of the auxiliary devices are protected from the elements by a ventilated

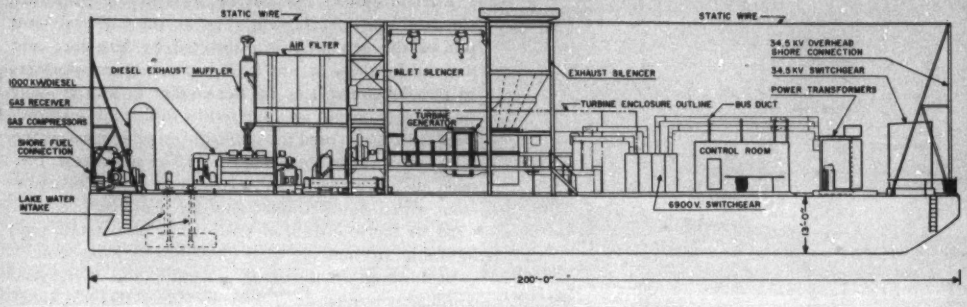

Fig. 2. Barge elevation, showing major equipment layout.

housing located amidships; the fuel system equipment is at the aft end of the barge; the electric equipment is at the bow. This arrangement provides maximum separation, for safety reasons, between the fuel system and the spark-producing devices of the electric system.

Gas Turbine–Generator. The gas turbine–generator unit consists of five major assemblies, arranged in line axially as follows:

1. Starting motor
2. Accessory gear and clutch assembly
3. Gas turbine
4. Generator
5. Exciter

The starting motor, accessory gear, and clutch assembly are used for cranking the turbine during start-up until the unit fires and becomes self-sustaining. The motor is a 550-hp 2,400-volt 3-phase 60-cycle wound-rotor induction motor coupled to the gas turbine shaft, at the compressor end, through an overriding jaw-type clutch and gear assembly. It is disengaged automatically from the turbine shaft at approximately 55% of full speed. A turning gear assembly, driven by a 5-hp 440-volt motor, is also included. It has several functions:

1. As a breakaway assembly, it provides the initial starting torque, thus reducing the power requirements of the cranking motor.
2. As a turning device, it keeps the shaft rotating slowly during the cool-down period to provide for uniform cooling of the turbine rotor.
3. As a jacking device, it can be used to rotate the rotor in small increments to permit inspection.

The turbine is a simple-cycle single-shaft 3,600-rpm unit rated 16,000 kw at standard NEMA (National Electrical Manufacturers Association) rating conditions of 80 F air temperature and 14.17 psi pressure, which corresponds to air pressure at an elevation of 1,000 feet. Under Lake Maracaibo conditions, with high ambient temperatures and sea level, the gas turbine will develop 15,200 kw.

The gas turbine assembly consists of a 15-stage axial-flow air compressor, 16 combustion chambers, and a 2-stage gas turbine. Atmospheric air is drawn into the compressor through air filters; it is compressed to about 90 psia and discharged directly to the combustors. In the combustion chambers, either gas or liquid fuel is fed to the hot compressed air stream, and at about 20% of rated speed the fuel and air mixture is ignited by spark plugs. Cross fire tubes which interconnect the combustors, of which there are 16 in number arranged axially around the unit, enable the flame from the fired chambers to propagate to the unfired chambers. Two Fireye flame detectors are installed in the combustion system to detect flame-out and to initiate shutdown of the turbine in event of flame-out.

The compressed air, after passing through the combustors where it is heated to approximately 1,450 F, drives the 2-stage turbine. In the two stages, in which the energy split is roughly equal, the gases expand to atmospheric pressure at about 830 F and then are dissipated to the atmosphere by the exhaust stack.

The generator is directly coupled to the turbine shaft at the exhaust end of the turbine. It is an air-cooled generator rated 18,823 kva at 0.85 power factor, 6,900 volts, 3-phase, 60 cycles, 3,600 rpm, Y-connected.

The exciter is direct connected to the generator and is rated 63 kw, 250 volts d-c, 3,600 rpm.

The over-all length of the turbine generator assembly is approximately 65 feet, and the width 15 feet. It is supported above deck on a structural steel base and the foundation is designed to limit deflection to 0.005 inch, which is within safe operating limits for the gas turbine, regardless of equipment, wind, or wave loads. The centerline of the gas turbine shaft is approximately 10 feet above deck.

Fuel System. The gas turbine is designed to burn either liquid fuel or gas. It is possible to change from one type of fuel to the other under load without shutdown. This changeover is completely automatic after being initiated by a permissive switch in the control room. If the generator is operated in parallel with other generators during fuel changeover, generator frequency will be held constant but generator load will vary slightly as a function of the heating values of the two types of fuel. If operating alone, the required load will

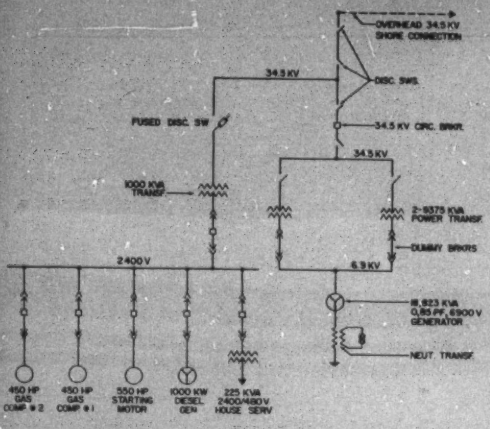

Fig. 3. Simplified one-line diagram of major electric equipment.

be carried and speed variation will be held to a minimum by the governor.

The liquid fuel suitable for use with this unit is Esso diesel, *C-6*, which can be used directly without any treatment or preheating to assure proper atomization. The heat rate at full load using distillate fuel is 16,200 Btu (British thermal units) per kwhr, or approximately 46 barrels of *C-6* diesel oil per hour at 15,000 kw, assuming a heating value of 19,300 Btu per pound.

The fuel-handling system for the liquid fuel is simple and straightforward. Fuel is brought to the barge through a small flexible hose from shore or from a fuel barge, either directly into the gas turbine fuel control system if the line pressure is about 100 psi, or into a small storage tank if the line pressure is low. A small booster pump is used to bring the pressure up to the desired level when the gas turbine is being fed from this auxiliary oil storage tank on the generator barge.

The fuel-handling system for gas is considerably more elaborate. The gas pressure required at the turbine is 150 psig, which is higher than the pressure of gas available at the Punta Gorda power plant. To boost the incoming gas to the required pressure, two full-capacity reciprocating-type gas compressors are installed at the aft end of the barge with a capacity of 5,150 standard cubic feet per minute (based on 14.7 psia and 60 F with a suction pressure of 50 psig and discharge of 150 psig). Each compressor is driven by a direct-connected 450-hp, 400-rpm, 2,300-volt 3-phase 60-cycle synchronous motor.

The gas connection to shore is made by 8-inch flexible hose through a centrifugal-type axial flow separator to the suction side of the gas compressors. The compressors discharge into a header connected to a 400-cubic-foot capacity gas receiver tank, and then through an aftercooler into the turbine fuel control system.

The heat rate using gas is 16,500 Btu per kwhr, or 265,000 cubic feet per hour at full load, assuming a heating value of 1,000 Btu per cubic foot.

Electric System. As can be seen in the simplified electrical one-line diagram (Fig. 3), the 6,900-volt output of the generator is connected by bus duct and dummy breakers to two 9,375-kva power transformers in parallel, which step up the voltage to 34.5 kv. The transformer output is connected by cable to 34.5-kv outdoor switchgear, used for synchronizing purposes, at the bow end of the barge. From the 34.5-kv switchgear, connections are made to an overhead dead-end structure from which power connections are made by overhead wires to shore. Overhead static wires and station-type lightning arresters are used for lightning protection.

In addition to the basic generator and switchgear equipment, a 1,000-kw 2,400-volt 3-phase 60-cycle diesel generator is installed on the barge to provide local power requirements during start-up, thus making the barge power plant completely self-sufficient. Another 60-kw 480-volt 3-phase 60-cycle diesel generator is installed on the barge to provide power during stand-by periods. This unit is also used to provide power for a 7½-hp air compressor required for control system air supply and for air starting the 1,000-kw diesel generator.

Control Facilities. The major control equipment is installed in a control house forward of the turbine housing. Within this control house are four rooms, as follows:

1. The air-conditioned soundproofed control room containing the turbine control panelboard, miscellaneous starters, relays, motors, control switches, and generator synchronizing devices. Control panel vibration is minimized by spring vibration dampeners.
2. A battery room with a heavy-duty nickel–cadmium storage battery and charger to provide 125 volts d-c for control and emergency power.
3. A resistor room for housing the resistor bank for the 550-hp wound-rotor induction-type starting motor for the turbine.
4. Convenience and storage facilities.

The control features of the barge power plant are unique in that the unit may be started, stopped, and controlled not only manually by an operator on the barge, but also automatically from a remote control point by means of direct-wire supervisory control. During initial start-up, an operator is required on the barge to set up the various valves for normal operation. Once set up, these manually operated valves do not require repositioning in normal operation. Thereafter, fully automatic operation can be effected, because all valves which require repositioning in remote start, operation, or shutdown are remotely operable and are incorporated in the automatic control scheme.

The remotely located control panel is installed in the control room for the existing steam plant at Punta Gorda. The Punta Gorda operator can do the following:

1. Start and stop the gas turbine–generator unit automatically.

2. Vary the generator output voltage and load.
3. Change fuel from gas to oil, or vice versa.
4. Open the generator load circuit breaker on emergency basis. Normal closing of this breaker is controlled by the automatic synchronizing equipment on the barge.
5. Control the barge lighting.

This remote control is performed by supervisory equipment requiring only a single pair of wires between the barge and the Punta Gorda control room. Additional control wires are installed, however, for barge-to-shore communication, telemetering of generator output information, pilot-wire relaying of the barge-to-shore electrical connections, and annunciator indications.

Miscellaneous Equipment. The cooling water requirements for gas turbines are usually very low; in this unit, only 550 gallons per minute of water at 95 F, or lower, are required. This need is provided by two full-capacity 25-hp cooling water pumps. To minimize corrosion due to brackish Lake Maracaibo water, a closed cooling water system is used. Parts of the lake water cooling pumps and of the heat exchangers, which are in contact with lake water, are made of suitable materials to prevent or minimize corrosion. The cooling water intake and discharge are located at opposite corners of the barge to minimize recirculation of the hot discharge.

The turbine–generator lubricating system uses a shaft-driven oil pump, a 75-hp auxiliary oil pump, and two oil reservoirs designed to assure adequate lubrication during extreme roll and pitch of the barge.

Two 12½-ton electric hoists are provided on the barge for use in maintenance operations. Sufficient laydown space, adequately reinforced, is available on the barge deck to permit removal and storage of turbine appurtenances without injury or deformation of the barge deck.

To minimize the fire hazard, gas and liquid fuel handling equipment, lines, relief vents, and tankage are located at a maximum distance from electric equipment, wherever possible. The turbine housing is designed free of pockets or dead space that may trap gases and is freely ventilated. The area is automatically purged prior to start-up of the unit. As an added precaution, carbon dioxide bottles and piping are installed at the generator, and hand fire extinguishers are mounted on brackets at critical areas. The oil-filled transformers are installed in a shallow well, sized to contain all of the transformer oil in the event of tank rupture. This well drains overboard by pipe to below water level.

Description of Shore Installation. The floating power plant described is installed in a dredged basin adjacent to Creole's existing steam electric power plant at Punta Gorda on the east shore of Lake Maracaibo (Fig. 4). The basin and approach channel were dredged to a depth of 10 feet, and this facility was sized to accept up

Fig. 4. Unit under test at basin outside the Punta Gorda power plant. At foreground is stern of barge, showing fuel-handling equipment.

to two additional units. The edge of the basin is riprapped to minimize erosion and silting.

The gas fuel supply for the unit is tapped off the existing gas supply for the Punta Gorda plant; for liquid fuel, a 5,000-barrel storage tank was installed on shore. A spit approximately 250 feet long and 30 feet wide was constructed from shore jutting into the basin to permit access to the barge, and to provide mooring facilities and underground installations of fuel lines and electric control cables. The underground lines and cables are brought to surface terminal devices at appropriate locations, and then connections are made to the barge by flexible hose or cables as required. As previously indicated, the high-voltage output of the barge generator is conducted to shore via overhead wires to a shore dead-end structure, and thence to the Punta Gorda power plant substation by underground cable in ducts.

Although installed inshore, this floating power plant is capable of operation in waters up to 100 feet deep provided wave and wind conditions are such as to limit pitch to 5 degrees and roll to 15 degrees maximum. Its ability to operate successfully in either shallow or deep water facilitates the relocation of this unit under emergency conditions, and permits the fulfillment of power requirements in a rapidly developing oil-producing area in the lake.

In addition to the mooring facilities and fuel and electrical connections, one very important shore installation is the control equipment. As previously mentioned, the control of the barge turbine and generator is via supervisory equipment. The master supervisory control panel is installed in the Punta Gorda control room and is incorporated as an extension of the existing Punta Gorda control panel. Also, the shore 34.5-kv breaker and the barge generator load breaker control are included in the extension to the existing control panel. Thus, in normal operation, the Punta Gorda operator will exercise the same control over the barge turbine–generator as is generally done for the existing shore power plant equipment.

Since only a limited amount of information will be telemetered from the barge to the shore control room, such as generator voltage, watts, vars, and station

alarms and shut-down signals, the shore operator will be more dependent upon automatic devices to protect the equipment than in the existing shore plant.

CONCLUSION

THE DECISION to depart from steam generation in making the latest addition to Creole's Punta Gorda steam electric plant at Lake Maracaibo was predicated on economic and operating considerations. The decision was influenced somewhat by the success with gas turbines in gas conservation plants at Lake Maracaibo. However, of more importance were the following considerations:

1. The initial cost of a gas turbine–generator installation is lower than a comparable steam turbine unit for Lake Maracaibo conditions.
2. Being a more compact unit, the gas turbine is more suitable for barge mounting than a steam unit with its steam generating facilities, rather extensive auxiliary equipment, and high cooling water requirements.
3. Operating personnel requirements of a gas turbine unit are lower than for a similar steam unit.
4. The gas turbine is more suitable for service where quick start-up and fully automatic or remote operations are desired.

Offsetting somewhat these advantages of a gas turbine are its lower over-all thermal efficiency and poor heat rate at partial loads. This is particularly true of simple-cycle single-shaft gas turbine units. However, thermal efficiency becomes of secondary importance in an area where fuel costs are low, such as in oil-field operations. For this reason also, heat-recovery equipment was not considered. Furthermore, heat-recovery equipment can become quite bulky and difficult to incorporate in a barge-mounted unit.

Barge mounting of the unit offers obvious advantages over fixed-station installation. A mobile power plant can be used to advantage in emergencies or to cope with a major shift of electric load during expanding operations. The alternative of making overhead extensions to remotely located major load areas is prohibitive cost-wise when such extensions are made in fairly deep water, such as Lake Maracaibo, where water depths of 100 feet or more are experienced. The cost of tower foundations rises sharply with water depth. In addition, the danger of tower or line damage due to ship traffic always exists in offshore oil operations, where drilling barges, rig movers, pile drivers, oil tankers, and numerous other craft ply around the clock. Submarine cable extensions can be made to such remote loads, but the amount of power that can be delivered to a remote point by submarine cable is rather limited. Furthermore, there is always the danger of loss of the cable due to anchor damage. Thus, a mobile power plant looks very attractive in the light of the foregoing considerations.

An additional advantage of barge mounting of the gas turbine unit is the fact that the unit can be completely assembled in a shipyard located near the source of supply for all equipment required for the project. Delays often encountered on foreign construction projects as the result of incomplete material shipments and scarcity of skilled labor can thus be minimized. For example, the unit described herein was built, checked out, run at partial load, and shipped overseas in less than 2 years; whereas steam plant additions of this size usually require well over 3 years to complete.

The cost of the complete installation, including shore facilities and mooring provisions at Punta Gorda was about $210 per kilowatt, which compares favorably with similar size installations during 1957 in the United States.

Satellites for Discoverer Program

Agena satellites being launched in the Advanced Research Projects Agency's scientific Discoverer program are shown as they go through modification and checkout of complex electronic equipment at the Lockheed Missiles and Space Division in Palo Alto, Calif. The satellites, launched into space from Vandenberg Air Force Base by the U. S. Air Force Ballistic Missile Division, are given a series of thorough checks of communications, instruments, propulsion, telemetry, and other systems before a "hot" engine firing at the Lockheed static test site in the Santa Cruz Mountains. The satellites are then sent to Vandenberg where they are launched into polar orbits by Air Force and Lockheed technicians to gather vital data on space conditions and capsule recovery techniques which will be helpful to United States space programs.

Impedance Bridge for Surface Temperature Measurement

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THE NONCONTACTING emissivity-free measurement of surface temperatures is a major problem in many industrial processes. In order to reproduce the temperature conditions that are found to give a satisfactory product, it is often desired to measure the surface temperature of metallic objects such as rolls or molds. The reliability of radiation pyrometers for these applications is frequently questionable for the following reasons:

1. The emissivity of highly polished surfaces is often uncertain and varying.
2. An error results from the absorption of radiation by gases or liquids interposed between the measuring element and the surface whose temperature is to be measured.

This article presents an instrument free of the aforementioned limitations that has been developed for a specific application: the measurement of the temperature of the glass-contacting surface of molds used in the pressing of glass objects. The measurement problem consists of detecting deviations of the surface temperature of the mold from a reference value. The molds are made of magnetic stainless steel. Inasmuch as the metal structure is extremely stable, its electrical and magnetic properties do not change with time and are temperature dependent only.

The instrument is based on a sinusoidal eddy current method and provides an output function of the mold surface temperature only; it is free from thermal drifts and permits accurate and reproducible temperature measurements over a wide range. A special circuit automatically minimizes the sensitivity to probe-to-surface spacing variations.

The instrument is basically a 200-cycle a-c comparison bridge followed by a phase-sensing detector. An iron-cored coil or probe placed in one arm of the comparison bridge projects an electromagnetic field into the surface of the mold.

The apparent impedance of the coil in the presence of the metal is affected by variations of the metal temperature and of the probe-to-metal spacing. Spacing variations of the order of 10^{-5} inch affect the probe impedance as much as a metal temperature variation of 1 degree C. When the bridge is initially balanced for a given distance and temperature, variations in these quantities result in unbalance voltages E_0 of distinct phases.

The phase detector detects that component of the error voltage that is in phase with the reference voltage E_r; if the reference voltage is in quadrature with that component of the error voltage corresponding to the effect of spacing variation, the output of the phase detector is temperature dependent only.

Theoretical considerations, experimentally confirmed, indicate that the phase of the component of the error voltage corresponding to spacing variation is temperature dependent; consequently, to attain accuracy in the temperature measurement it is necessary to adjust continuously the phase of the reference voltage when the surface temperature changes.

The sensing coil is vibrated at low frequency, 20 cycles by the modulation motor, in order to modulate the probe-to-metal spacing sinusoidally. This results in an amplitude and phase modulation of the error voltage E_0. The phase of the reference voltage E_r is adjustable by the phase shifter whose position is controlled by a servo system. As long as the phase of the reference voltage is not correct, a 20-cycle component is present in the output of the phase detector. This component is the error signal, the input of the servo system that adjusts the phase shifter position until the 20-cycle component disappears from the output of the phase detector, at which time the output is a function of the mold surface temperature variation only.

Other features have been incorporated to obtain a high degree of stability in the instrument readings. The impedance of the sensing coil alone is periodically compared to that of a reference inductor. Any impedance difference, due to aging or ambient temperature variations, for example, is compensated for by two servo systems that adjust variable resistance and reactance components. Other critical components of the instrument are mounted in a constant-temperature oven.

The instrument can operate continuously and detect surface temperature variations of the order of 1 degree C at temperatures up to 500 C. The over-all time of response is about 5 seconds, although, when balanced, a 5-degree C per second rate of change of surface temperature can be followed. The output is not affected by probe-to-metal spacing variations of 0.01 inch. The measurements are emissivity-free and are performed without contacting the mold surface. Not even direct optical view is required.

The measurement technique is applicable to temperature measurements of conductive nonmagnetic bodies. In this case, if surface temperature measurements were desired, it would be necessary to operate at higher measurement frequencies.

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Pictorial Data Transmission from a Space Vehicle

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Space communications pose a unique set of problems in line-of-sight transmission. Major ones include nonstationary terminals, the astronomical distances involved, and bandwidth restrictions consistent with power restrictions. There are also conflicting requirements of maximum reliability and minimum weight of equipment.

MANY of the problems of communication with a space vehicle are not in themselves unique because they are primarily line-of-sight communication. The combination of these problems related to space vehicle communications is, however, rather unusual, and possible solutions to meet both present and future requirements are of interest to both the communication and television engineer. Major problems include the literally astronomical distances involved; nonstationary terminals which may be moving many tens of miles per second relative to each other; and bandwidth restrictions consistent with the power restrictions. These areas are closely related in that efficient use must be made of the available bandwidths with modulation schemes that do not necessitate overly complex equipment. There are also the apparently conflicting requirements that the equipment must be very reliable as well as light in weight and small in size.

DESIGN CONSIDERATIONS

ONE OF THE FIRST CONSIDERATIONS is that of choosing a carrier frequency. For space communications, a frequency high enough to penetrate the ionosphere must be used. There is a great deal of man-made noise below 30 mc, as well as cosmic noise at higher frequencies. At higher and higher frequencies, the noise continues to drop until, between 10 and 20 kmc (kilomegacycles), the noise level again rises due to the water vapor. Fig. 1 illustrates the noise temperatures and their sources. From the graph it may be concluded that frequencies for communication purposes must be between approximately 150 mc and 10 kmc. The choice within these limits depends upon the power requirements and the state of the art. For example, in a low-power space-vehicle transmitter, one might look to solid-state devices for reliability and efficiency, a choice which then limits the frequency to the few hundred megacycle range. As devices of higher frequencies are improved for space use, higher frequencies will be used. The present state of the art, in fact, indicates that the 1,000-mc range is an optimum choice for some systems. The one important factor that should influence any system design for space communication is reliability. The most sophisticated theoretical system is worthless if it is not reliable, so that it is far better to have a basically simple system with emphasis on reliability.

A considerable variety of television systems may be used in space probes; some may bear little likeness to what is commonly called television. It is beyond the scope of this article to discuss pickup devices, scanning modes and methods, and storage equipment. The scanning devices may be electrical or mechanical, or both, and the storage device may be a vidicon or some form of tape storage. The communication problem may be described adequately by discussing the image in terms of the number of picture elements. Since one cycle will describe two picture elements, the product of frequency bandpass and time of transmission is a constant for any picture of given resolution. This permits the trading of bandwidth for time of transmission.

The determination of required signal-to-noise ratios depends on the over-all system requirements and in many instances is made on a subjective basis. Shown in Fig. 2 is a 500-line picture of what may be expected to be seen on the surface of the moon with a 10-db signal-to-noise ratio. The signal-to-noise ratio is defined in this paper as 20 log (peak-to-peak video voltage/2 rms noise voltage). It is noted that, although for some applications this may be adequate, it leaves something more to be desired. Fig. 3 is the same view with a 20-db signal-to-noise ratio. These pictures were taken with an exposure of one frame and are not as good as visual observation of the same signal-to-noise ratio at standard television rates. This is because the eye tends to integrate the noise and signal over several frames when viewing standard television. One can also determine the required signal-to-noise ratio in terms of the required number of distinguishable gray levels and object size. In this case, the noise power spectrum and the first and second order statistics of the noise must be taken into account.

Power consumption economy and circuit simplicity usually govern the type of modulation to be used. Narrow-band FM has several advantages; one advantage is the noise improvement factor due to the shape of the output noise spectrum. This results in a lower transmitter power. Other advantages are the comparatively low modulating power required, the relative simplicity of FM transmitter circuits, and the capability of wide dynamic range where it is required.

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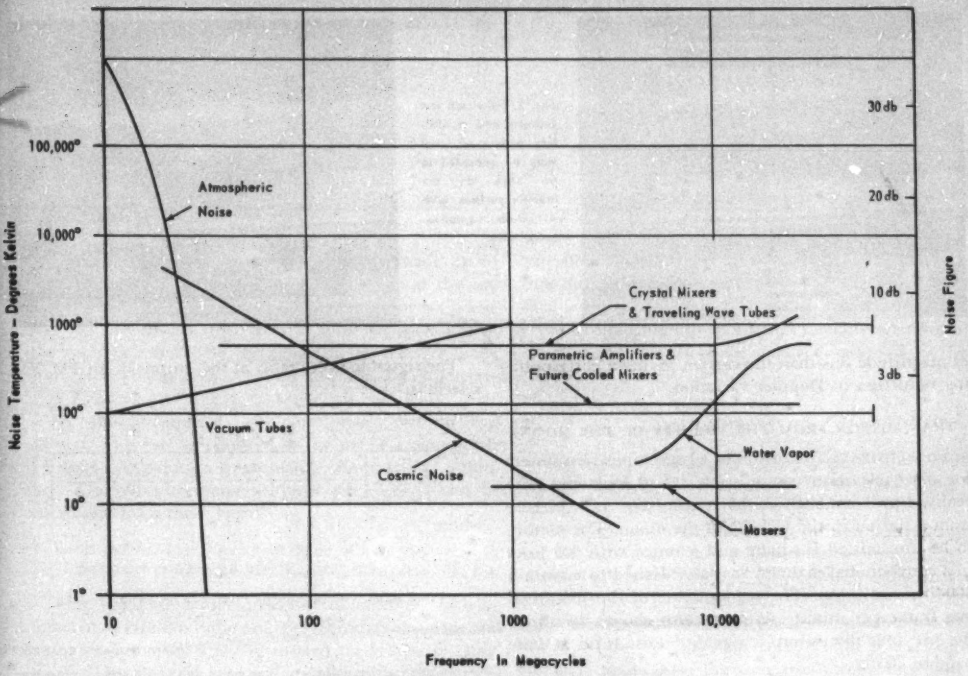

Fig. 1. Equivalent noise temperature vs. frequency.

In comparison, pulse-modulation techniques require larger bandwith or more circuitry; AM requires considerably more modulator power, and single side band much more circuitry. Phase modulation has many of the advantages of FM, but does not have the noise improvement capability.

The slow transmission rate requires that the system be essentially d-c coupled. In an FM system the Doppler-shift frequency variations would act the same as a low-frequency signal. The amplitude of this variation is directly proportional to the frequency shift and can be quite large. From the series expansion relating the Doppler shift to the radial velocity of the two terminals, it is seen that the higher-order terms can be neglected when the radial velocity is small compared to the speed of light. For example, a change in vehicle velocity of 1 mile per second would produce a shift of 5.4 kc in the case of a 1-kmc carrier.

$$f' = f\left(1 \pm \frac{V}{c} \pm 1/2\,\frac{V^2}{c^2} \pm 1/2\,\frac{V^3}{c^3} \cdots\right)$$

where

c = velocity of light

V = radial velocity of vehicle

f = original frequency

f' = shifted frequency

for

$$c \gg V$$

$$f' = f\left(1 \pm \frac{V}{c}\right)$$

and

$$\Delta f = \pm f\,\frac{V}{c}$$

if

f = 1 kmc

V = 1 mile/sec, and

Δf = 5.4 kc

In most cases variations of this order would be intolerable. Phase or amplitude modulation is of no help since there is no d-c capability. Digital pulse modulation does have d-c capability, but the large bandwith requirements make it unattractive. The problem is solved by the use of a subcarrier. The information signal modulates the subcarrier which in turn modulates the carrier. FM is generally used for the subcarrier for the same reasons that apply to the carrier. The Doppler shift of the subcarrier follows the same relationship as that of the carrier; however, its center frequency is many orders

Fig. 2. Television test pattern and a 500-line picture of what may be expected to be seen on the moon's surface with a 10-db signal-to-noise ratio.

of magnitude less than the carrier, giving a corresponding reduction in Doppler variation.

TRANSMISSION FROM THE VICINITY OF THE MOON

To ILLUSTRATE THE DESIGN of a communication system for space-television transmission, let us look at a very realistic problem such as the transmission of a picture from a station in the vicinity of the moon. The picture to be transmitted is square and scanned with 500 lines in a conventional manner. It is also desired to maintain 500-line resolution. The readout rate of the picture is one frame per minute. We may also choose, based on the previous discussion, a signal-to-noise ratio at base band of 20 db.

The bandwidth requirement is:

$$\text{BW} = \left(\frac{\text{no. of picture elements}}{2 \times \text{time in seconds}}\right) \text{ or } \text{BW} = \frac{500 \times 500}{120} = 2.100 \text{ cps}$$

An FM/FM modulation scheme with the following parameters is selected:

Subcarrier frequency	5,000 cps
Modulation index (subcarrier)	1
Video base-band bandpass	0 – 2,100 cps
Carrier frequency	1 kmc
Modulation index	1
I-F (intermediate frequency) bandwidth	20 kc

The signal-to-noise ratio at the output of an FM/FM system is:

$$\frac{S}{N} = \frac{C\sqrt{B}\,F_1\,F_2}{N_{IF}\sqrt{2\left[\frac{f_2^5}{5} - \frac{f_{sc}f_2^4}{2} + \frac{f_{sc}^2 f_2^3}{3} - \frac{f_1^5}{5} + \frac{f_{sc}f_1^4}{2} - \frac{f_{sc}^2 f_1^3}{3}\right]}}$$

where

$\frac{S}{N}$ = rms signal voltage-to-rms noise voltage ratio

$\frac{C}{N_{IF}}$ = rms carrier voltage-to-rms noise voltage in the i-f amplifier

B = bandwidth of i-f amplifier
F_1 = r-f carrier peak deviation
F_2 = subcarrier peak deviation
f_{sc} = subcarrier center frequency
f_m = cutoff frequency of video output circuits
$f_1 = f_{sc} - f_m$
$f_2 = f_{sc} + f_m$

substituting:

$B = 2 \times 10^6$
$F_1 = 7 \times 10^5$
$F_2 = 2.1 \times 10^5$
$f_{sc} = 5 \times 10^5$
$f_m = 2.1 \times 10^5$
$f_1 = f_{sc} - f_m = 2.9 \times 10^5$
$f_2 = f_{sc} + f_m = 7.1 \times 10^5$.

Fig. 3. This is the same view as Fig. 2 but with a 20-db signal-to-noise ratio.

We find that the required signal-to-noise ratio in the i-f passband is 3.6 or 11 db.

The noise power in the i-f passband referred to the receiver input is given by $P_n = KT_eB$

where

P_n = noise power
K = Boltzmann's Constant
T_e = effective noise temperature (K)
B = i-f bandwidth

The effective noise temperature (T_e) is made up of two components; the effective temperature at the antenna terminals (T_a) when connected to a perfect noiseless receiver and T_r the effective noise temperature of the receiver referred to the input of the receiver when connected to a perfect noiseless antenna. By superposition $T_e = T_a + T_r$

For this example a 2-db noise figure receiver was chosen. This can be achieved by the use of a parametric amplifier preceding a conventional low-noise i-f amplifier. The effective temperature of the receiver can be computed from the relationship

$T_r = 293\ (NF\text{-}1)$ where NF = noise figure of the receiver.
For a 2-db receiver $NF = 1.6$, and $T_r = 293\ (1.6 - 1) = 175°$ K.

The antenna temperature is determined by the amount of random radio energy received from space and through side lobes oriented toward the relatively "hot" earth. There is also a contribution due to losses in the antenna and the transmission lines to the receiver. The actual noise temperature is a function of the direction of the antenna beams, but a good approximation can be made of about 100 K, providing the side lobes are well suppressed and the beam is not pointing at a particular "hot" source such as the sun. The total effective noise temperature for this example is then

$$T_e = 100 + 175 = 275° \text{ K}$$

and the noise at the input of the receiver is

$$P_n = KT_eB = 1.36 \times 10^{-23} \times 2 \times 10^4 \times 275 = 7.5 \times 10^{-17} \text{ w or } -161 \text{ dbw}$$

This means that the receiver power (P_r) must be -161 dbw $+ 11$ db or -150 dbw. Using the well known transmission equation

$$\frac{P_r}{P_t} = \frac{G_tG_r\lambda^2}{(4\pi d)^2}$$

where

G_t = gain of the transmitting antenna over an isotropic antenna,
G_r = gain of the receiving antenna over an isotropic antenna,
λ = wavelength,
d = distance in the same units.

For the system described:

$$d = 250{,}000 \text{ miles} \times 1.609 \times 10^3 = 4.02 \times 10^8 \text{ meters}$$

$$\lambda = \frac{300}{1{,}000} = 0.3 \text{ meters}$$

$$\therefore \frac{P_r}{P_t} = \frac{(3 \times 10^{-1})^2}{(4\pi \times 4.02 \times 10^8)^2} G_tG_r = [0.351 \times 10^{-20}\ G_tG_r]$$

$$\frac{P_r}{P_t} = -204.5 \text{ db} + G_t \text{ (db)} + G_r \text{ (db)}$$

or the loss between isotropic antennas is 204.5 db. Choosing from reasonable and available antenna systems, the ground antenna is a 60-foot dish with vertical and horizontal feeds and polarization diversity. The expected gain of such an antenna is 43 db. This does not constitute the highest-gain antenna in existence, but an available size. The vehicle antenna is a circularly polarized crossed dipole used in an attempt to achieve an isotropic antenna. The gain of this antenna is about -3 db. Then

$$\frac{P_r}{P_t} = 204.5 - 3.0 + 43.0 \approx -165 \text{ db}$$

Therefore, if the power received must be -150 dbw, the transmitter power required is -150 dbw$-(-165$ db) or 15 dbw. Allowing a 10-db margin for equipment deterioration and nonoptimum operating conditions making the transmitter power 25 dbw or approximately 300 watts (still a rather high power considering that the efficiency may be in the order of 20%), the power requirement would be 1,500 watts.

One of the obvious ways to reduce the power requirement is to increase the time of transmission, but the total energy required for the transmission of one picture is still the same. The weight and size of the transmitter are reduced, however, to that of a 30-watt transmitter if the time is increased, for instance, to 10 minutes. However, there may be some advantage, as a function of realizable efficiency, in using one rather than the other transmitter, provided either transmission time is acceptable.

A more advantageous solution is obtained by increasing the gain of the antenna system. Some vehicles may be stabilized to maintain the optical axis orientation, in which case it may be feasible to use a directional instead of the isotropic antenna. This antenna would be even more feasible if the space probe were to land on the moon.

Since the angle subtended by the earth is approximately 1.8 degrees, the earth could be tracked by infrared sensors which could provide data for pointing at the center of the earth as long as the beam width of the antenna was large enough to illuminate the earth. An example of this is a 5-foot dish which has a gain of 21 db. The beam angle is given in degrees by

$$\theta = \sqrt{\frac{27{,}000}{G}}$$

where G is the gain of the antenna or in this case 125. Therefore

$$\theta = \sqrt{\frac{27.000}{125}} = 14.7°$$

Table I. Energy Required for Each Picture.

Time of transmission (One frame)	Radiated power (watts)	Input power (at 20 % efficiency)	Total energy, whr	Antenna gain (db)
1 minute	300	1,500	25	$G_t = -3$ $G_R = 43$
10 minutes	30	150	25	$G_t = -3$ $G_R = 43$
1 minute	1.25	6.25	0.105	$G_t = 21$ $G_R = 43$

Table II. Specifications of Moon-to-Earth System.

Picture resolution	500 × 500 lines
Number of elements	250,000
Transmission time	1 min.
Base band	2100 cps
Range	250,000 miles
Receiver	
I-F bandwidth	20 kc
Noise figure	2 db
Antenna	60-foot dish
Gain of antenna	43 db
Transmitter	
Carrier frequency	1 kmc
Type modulation	FM
Peak deviation	±7 kc
Antenna	crossed dipoles circularly polarized
Antenna gain	−3 db
Subcarrier	
Center frequency	5 kc
Type modulation	FM
Peak deviation	±2.1 kc

This is a reduction of power required by 21 db—(−3 db) or 24 db. The power required with the isotropic antenna was 25 dbw or 300 watts, but now is 25−24 = 1 dbw which is 1.25 watts. This is a very reasonable power requirement and within the present state of the art for using solar cell power supplies. This saving must, however, be weighed against the increased power consumption and the weight required to track the antenna, which depends upon the particular probe (since some probes lend themselves more easily to antenna stabilization by virtue of the requirements of the primary experiments aboard the vehicle).

This same gain could be realized by increasing the gain of the ground receiving antenna, but it would require a dish well over 600 feet in diameter to effect the same gain as the 5-foot dish on the vehicle. Table I illustrates the energy required for each picture for the different component selections.

CONCLUSION

THIS DISCUSSION is not intended to provide fixed rules for the design of a communication system for space vehicles, but rather to point out some of the major areas to be considered. It has, however, illustrated the practicability of instrumenting such a system. The actual configuration of a system will depend on the mission and payload capabilities. General conclusions can, however, be made such as the advantage of using FM subcarriers for video transmission. Higher carrier frequencies will be used because of the lower noise level and increased antenna gain as practical equipment becomes available. It will then be very helpful to use low-noise amplifiers such as the maser.

Fuel Elements for Belgian Nuclear Reactor

Being readied for shipment to the Westinghouse Reactor Evaluation Center at Waltz Mill, Pa., is one of 40 fuel elements designed and built by Westinghouse Electric Corp. for use in Belgium's first atomic power plant. The fuel rods were assembled at the company's atomic power department. When the reactor core is completed, it will consist of 32 fuel elements, each with a total of 110 tubes which contain pellets of uranium oxide, the nuclear fuel for the reactor. The remaining eight elements will be used as spares. Last year, the Atomic Energy Commission issued Westinghouse the first license for export of a United States manufactured power reactor. The 11,500-kw power plant is scheduled for operation in September 1960, at Mol, Belgium. Westinghouse designed and developed the reactor portion for the Centre d'Etude de l'Energie Nucleaire, a nonprofit organization formed by the Belgian government, scientific centers of the universities, and Belgian industry. Shown loading the fuel element into its shipping container are some technicians of the Westinghouse atomic power department, located in Forest Hills, Pa.

Experimental Fault-Locating Work on Pipe-Type Cable

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THE INCREASED USE of high-pressure oil-filled pipe-type cable lines within the Commonwealth Edison Company prompted a re-evaluation of fault locating methods. Known measurement methods are inadequate for pipe-type cable lines.

New fault-locating methods and equipment were developed to supplement existing methods and tested using various simulated fault conditions on pipe-type cable lines. As a final check on the workability of both the existing and newly developed fault-locating methods, tests were made on a new 12-mile 138-kv pipe-type cable line using faults which were built into two of the three conductors in a joint. It was concluded that faults can be located quickly and accurately by a 2-step procedure: first, an approximate location; and second, an exact location.

OBTAINING THE APPROXIMATE LOCATION

THE MURRAY LOOP is the most accurate of all approximate methods, but it requires a fault characteristic which permits a steady flow of direct current. The average of five measurements during the tests on the artificially faulted pipe-type cable line resulted in an average error of 11 feet, the largest error of any measurement being 28 feet.

Radar, or the reflected impulse method, has its optimum value on open circuits, near zero-resistance short circuits, or other type faults having large impedance discontinuities. A trial on the faulted pipe-type cable line resulted in an error of 102 feet.

The newly developed methods allow an approximate location of an arcing-type fault. The errors of measurement of the two methods are in the range of 100 to 300 feet.

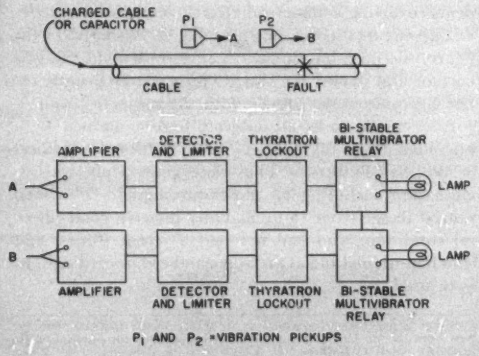

Fig. 1. Sound-directional indicator.

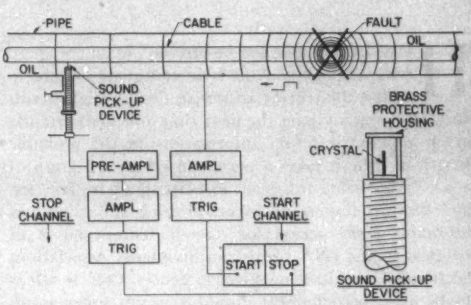

Fig. 2. Sound-distance method.

The first method, known as electric-pulse timing, makes use of the two electric pulses originating at the fault which travel in opposite directions along the line. The difference in arrival time at two terminals is measured and compared with the known time of pulse travel for the total cable length to determine the location of the fault.

The resonant-line method makes use of the electric resonant frequency characteristic of the line. The location of the fault is found by measuring the resonant frequency of the line between a terminal and the fault and comparing it with the resonant frequency of the line between the terminals.

PINPOINTING THE FAULT

THREE PROPERTIES of a sound or shock wave created by an electric discharge at the fault furnish the basis for three exact or pinpointing methods:

1. Measurement of the amplitude, or sound-level method.

2. Determination of the direction of propagation, or sound-directional method. Equipment developed for this method is illustrated in Fig. 1. The pickup unit which is nearer the fault is actuated first, locking out the other unit, and so determines the direction to the fault.

3. Use of the speed of propagation, or sound-distance method. The principle is illustrated in Fig. 2. The time interval between the arrival of the electric pulse and the sound pulse is measured and used to obtain the distance to the fault.

Digest of paper 59-162, recommended by the AIEE Insulated Conductors Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, New York, N. Y., Feb. 1-6, 1959. Published in AIEE *Power Apparatus and Systems*, Oct. 1959, pp. 821-29.

H. L. Garton, C. Jasper, and H. R. Winemiller are with the Commonwealth Edison Company, Maywood, Ill., and E. J. Steeve is with the Commonwealth Edison Company, Chicago, Ill.

Paralysis Following "Freezing" to a Wire

C. F. DALZIEL
FELLOW AIEE

HOW LONG will you be "frozen" to an energized wire after the circuit is interrupted? Failure to utilize the correct answer in design might result in your being a victim the next time you inadvertently grasp an electric fence. Information on the probable length of time it takes a person to release his grasp of a wire after being subjected to currents above his "let-go" limit is important in establishing the minimum allowable "off" period for electric fences and is of concern to the ASA (American Standards Association) Sectional Committee on Electric Fences, C69. Death is to be an expected result should a victim suffer a sufficient number of shocks due to his inability to release his grasp of an electrified fence during the "off" period between consecutive shocks.

Fig. 1 shows data obtained on 32 men to determine the maximum probable time delay in releasing a conductor following interruption of a 60-cycle current slightly in excess of the individual's let-go current. Each subject was given a 60-cycle current sufficient to freeze him to a no. 8 copper wire. While he was struggling in the attempt to let go of the wire, the 60-cycle current was interrupted and a timer operated on a few milliamperes of 250-kc unperceptible current

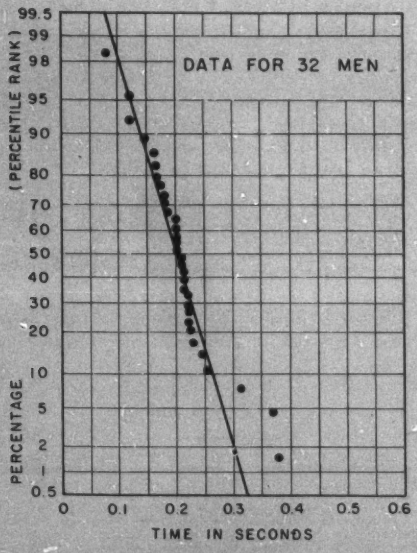

Fig. 1. Let-go time lag distribution curve, showing time delay in releasing a no. 8 copper wire following interruption of a 60-cycle "freezing" current.

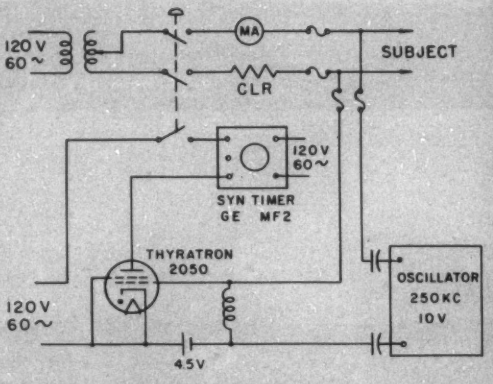

Fig. 2. Circuit used in determining time delay when "freezing" 60-cycle current is interrupted.

measured the time interval between interruption of the 60-cycle current and release of the wire. The results indicate that 3 men out of the 32 had a time delay of nearly 0.4 second. The tests were limited to currents 2 to 4 milliamperes in excess of the individual's let-go current, and no tests were made with impulse currents. Thus, it is possible that the let-go time delay might be longer for higher 60-cycle currents and for short impulses of 100 or more milliamperes as used in some types of electric fence controllers. The "off" period presently required varies from about 0.75 to 1.0 second. This amounts to a factor of safety of approximately 2, based on 60-cycle freezing currents. This "off" period has been used for a considerable number of years, and is considered satisfactory because of the lack of reported accidents involving commercial electric fence controllers.

The circuit used is shown in Fig. 2. As noted in the figure, the push-button switch interrupted the 60-cycle current and started the timer which operated until the test electrode broke contact with the subject's hand.

Prior to the tests all subjects were examined by a physician from the University of California Medical School, San Francisco. They were given a physical examination including an electrocardiogram. The men ranged in age from 18 to 50. Only those in good physical condition, who had not had a recent illness, and who had normal blood pressures and electrocardiograms were used.

Full text of paper 60-3, presented at the AIEE Winter General Meeting, New York, N. Y., Jan. 31–Feb. 5, 1960. Recommended for publication by the AIEE Safety Committee.

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Long Time Delays from a Single Magnetic Storage Core

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ACCURATE TIME DELAYS are essential to both industrial and military control. Static devices presently available provide delays accurately and economically up to a few seconds. The emphasis on reliability in these fields has made it desirable that a static device be developed to generate long time intervals.

The static device described uses magnetic cores with essentially rectangular hysteresis loops, and transistors as switches. Accuracies of better than 1% are achieved for time intervals less than 1/10 second up to several minutes.

The property of a rectangular-loop magnetic core to absorb a fixed volt-second integral as determined by the flux change from one saturation level to the other has been used in short time delays by G. F. Pittman,[1] J. L. Lowrance,[2] R. L. Van Allen,[3] and others. The present device uses this basic property in such a way that the time delays achieved in a single stage are much longer than in previous designs.

In the device described by Pittman, this fixed volt-second value is used to advantage. By pulsing the magnetic core with unidirectional pulses of fixed volt-seconds, the core flux is changed from $-\Phi_s$ to $+\Phi_s$ in discrete steps. The time delay is determined by the rate and number of these volt-second pulses. This can be expressed as follows: where n is the number of pulses, N is the number of turns, Φ_s is the saturation flux density in lines, e is the instantaneous value of the core voltage applied for the time interval Δt.

$$n = \frac{2N\Phi_s}{\int_{\Delta t} e\,dt} \times 10^{-8} \qquad (1)$$

The present device extends this basic reasoning to include the proposition that this voltage function need not be unidirectional. Time delays are achieved by alternately pulsing the core with positive and negative volt-second pulses. The difference between the positive and negative pulses is adjusted to be a few microvolt-seconds. The time interval which can be generated is determined by the number of times this difference must be applied to the core in order to change the flux level from one saturation to the other. The number of full cycles which must be applied to the core to accomplish this flux change can be expressed:

$$n = \frac{2N\Phi_s}{\text{(Difference Volt-Seconds)}} \qquad (2)$$

The smaller the difference between the positive and negative pulses, the greater the values of n. Experimentally, it is not difficult to achieve values of n in excess of 7,000 with a single storage core. Since this number can be made so large, the pulses can be taken directly from a 60-cycle power source with time delays of 2 minutes using a single magnetic core. Using unidirectional pulses, four stages would be required to produce an equivalent time interval.

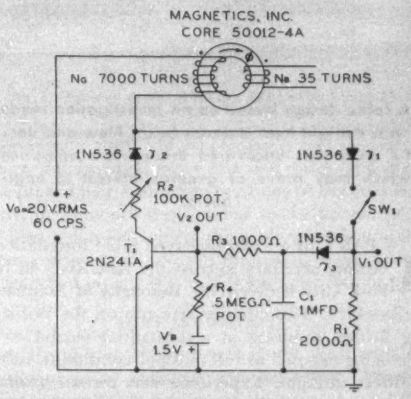

Fig. 1. Single-stage time delay.

The circuit of the device is shown in Fig. 1. The core is excited with an asymmetrical a-c voltage. This is accomplished by making the values of the resistors R_1 and R_2 different, by making these resistors equal and biasing the magnetic core with a direct current through the bias winding N_B, or by introducing a d-c potential in series with the a-c excitation. Each of these has the effect of causing the core voltage to assume different volt-second values on alternate half cycles. Timing is initiated when switch S_1 is closed.

The device was checked experimentally over a voltage and frequency range of $\pm 10\%$ each and over a temperature range -20 C to $+60$ C for different values of time delay with less than 1% error.

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Digest of paper 59-176, recommended by the AIEE Magnetic Amplifiers Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, New York, N. Y., Feb. 1-6, 1959. Published in AIEE *Communication and Electronics*, Nov. 1959, pp. 457-61.

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Thermal Environmental Factors Affecting Exposed Pipe-Type Cable

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A cable design based on an investigation made on a straight heat balance basis. New and useful data was uncovered through an approach which may prove of general interest to engineers.

AS PART of a 69-kv pipe-type cable installation it became necessary to cross the East River in New York City between the Boroughs of Manhattan and Brooklyn. Two circuits were run on the Williamsburg Bridge, resulting in a substantial section of the route being exposed to full outdoor conditions, including direct sunlight. Experience and certain available data are sufficient to develop a design that should operate satisfactorily under these thermal conditions; however, it was thought to be of interest to effect an independent check on a straight heat balance basis.

The heat exchange takes place at the exterior surface of the pipe. Heat delivered consists of circuit losses from within and heat absorbed from sunlight. Heat is dissipated by radiation and convection. The pipe surface is considered an isothermal surface. While not exact, this assumption permits an answer to be obtained in terms of a mean effective temperature for the pipe. The internal temperature gradient, determined in the usual way, is added directly to this to get the operating temperature of the conductors.

The two pipes are spaced horizontally 18 inches apart center-to-center, and, therefore, are considered reasonably isolated from each other. The data for each circuit for the run on the bridge are:

Cables:	3-phase system, 69 kv, 60 cycles. One 1 million circular-mil compact segmental copper conductor per phase, 405-mil paper insulation, 2 copper shielding tapes and bronze skid wire.
Pipe:	Steel, 6⅝ inches OD, 5⅞ inches ID, ⅜ inch wall. Painted surface, black.
Pressure medium:	Nitrogen gas, 200 psi (pounds per square inch) nominal operating pressure.

AMBIENT TEMPERATURE

ACCORDING TO LOCAL WEATHER RECORDS, the annual maximum ambient (air) temperature is apt to occur during the month of July, and particularly the latter half of the month. This maximum seldom exceeds 95 F, only 4% of the recorded maxima being above that value. This information is derived from an unpublished analysis made by the New York office of the U.S. Weather Bureau for the years 1871–1957. In order to allow for reasonably severe conditions, it was decided to use an ambient temperature of 95 F. This is 35 C.

INCIDENT SUNLIGHT

MAXIMUM INCIDENT SUNLIGHT CONDITIONS are apt to occur somewhat earlier in the year than the maximum ambient temperature. The sun is higher in the sky in June than in July, and while this will not alter the amount of sunlight of a given intensity impinging upon a cylindrical object, such as a pipe, with its axis in an east-west line, it does mean that the sunlight has to pass through a greater atmospheric distance than at time of the summer solstice. Perhaps more important, the humidity is apt to be greater in July and early August than in June. Also, the dust and pollen count may be up if there has been a period of dry weather.

The U.S. Weather Bureau operates a solar radiation recording station in Central Park. This measures and draws a curve of the heat absorbed by a horizontal surface on an instrument called a pyrheliometer. Records are averaged on an hourly basis, each hourly value being the average of three values from the curve for the given hour. Records are in Langleys, a Langley being a gram-calory per square centimeter per hour, which is 3.68 Btu (British thermal unit) per square foot per hour or $3.68 \times 0.293 = 1.078$ watt per square foot. On a typical high radiation day, which would be clear and substantially cloudless, the average of three readings for the peak hour is not much below the peak of the curve. Although the thermal capacity of the cable-pipe system is not great, it would seem that an hourly average would be a suitable basis to use.

The maximum pyrheliometer record for the year 1958, which happened to be a rather high maximum, was 96 Langleys, occurring on June 6, between 12 noon and 1 p.m. This is 354 Btu per square foot per hour, but on a horizontal surface. Considering the noon height of the sun for that date, this amounts to 372 Btu per square foot per hour at right angles to the sun's rays, disregarding any inaccuracy in treating the full sky component in this manner.

The Standard Handbook for Electrical Engineers[1] gives the following as reasonable values for heat from incident sunlight at 12 noon on August 1 for 40°

A special article recommended by the AIEE Insulated Conductors Committee.

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north latitude: 298 Btu per square foot per hour on a horizontal surface and 94 Btu per square foot per hour on a vertical surface facing south. These values combine to a total of 312 Btu per hour perpendicular to the sun's rays. However, this combination does not check exactly with the sun's height for the date. On solar angle, the 298 would give 322 Btu per square foot per hour, while the 94 would give only 250. Nevertheless, these may be taken as in reasonable agreement with the Weather Bureau data. A recent paper on ACSR (steel reinforced aluminum cable) cable by House and Tuttle,[2] drawing on the Heating, Ventilating and Air Conditioning Guide, implies comparable but possibly lower values.

While there is an interesting fund of data available on the subject of climatology, further details relating to the steps by which the assumed conditions were selected will not be included here.

On the basis of the information reviewed, and giving most weight to the actual measurements of the Weather Bureau, it was decided to use a design value of 350 Btu per square foot per hour or 102.5 watts per square foot for the black body absorption of sunlight on a surface perpendicular to the sun's rays. Coupled with the 35 C ambient, this should give a fairly severe design premise, but not unreasonably so. Actual thermal performance will depend upon the exterior finish of the pipe. There are not many details available on the thermal characteristics of specific paints. However, the results of an extensive study for electrical apparatus, particularly in relation to transformers, were published a number of years ago in the AIEE *Transactions*.[3] In this reference, a solar absorption factor of 0.75 and a low temperature radiation factor of 0.95 are given for gray transformer paint. The Standard Handbook for Electrical Engineers[4] also gives 0.95 for the emission factor for gray paint. Although the pipe eventually was painted black, the values for transformer gray have been used in the computations (the emission factor is used later, under "radiation").

The above analysis leads to evaluation of the component of heat absorbed from the sun. The heat balance calculations are to be made on a per-foot-of-pipe basis. The projected area of one foot of pipe is 0.552 square foot. The heat absorbed from the sun is, then

$$H_s = C_s \, W_s \, A_p \text{ watts per foot of pipe}$$

where

C_s = coefficient of absorption of solar radiation
W_s = energy of sunlight in watts per square foot of surface perpendicular to rays
A_p = projected area of absorbing surface perpendicular to sun's rays, in square feet

Substituting values just determined

$$H_s = 0.75 \times 102.5 \times 0.552$$
$$= 42.4 \text{ watts per foot of pipe.}$$

CIRCUIT LOSSES

THE OTHER HEAT CONTRIBUTION is the circuit losses. These are made up of simple resistance losses and dielectric losses, plus additions for proximity and skin effect, losses in the shielding tapes and skid wires, and losses in the pipe. Their evaluation need not be detailed here as only their amount is of interest to the present problem. The design loading for the cable was taken as 614 amperes. Suffice it to say that the result, expressed per unit length of pipe is $W_1 = 18.0$ watts per foot of pipe.

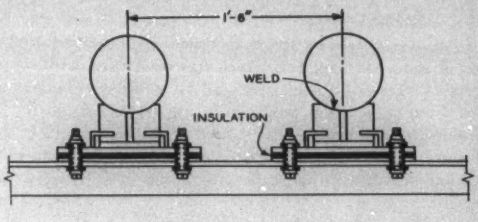

Fig. 1. Mounting details of the two pipes on the bridge.

HEAT DISSIPATION

THE OTHER SIDE of the heat balance deals with the heat dissipated by radiation and convection. There is no loss by simple conduction as the pipe is supported in spans of several feet.

The heat dissipated will be formulated in terms of the surface temperature of the pipe. For convenience in working the equation, the temperature will be given in degrees Kelvin (= degrees C + 273). Equating the heat delivered and heat dissipated will yield a solution for the temperature of the pipe.

RADIATION

RADIATION IS TREATED in accordance with the regular Stefan-Boltzmann law. Adjusting the form of it given in the Standard Handbook[4] gives

$$H_r = 144 \text{ K } C_r \, (T_p^4 - T_a^4) \, A_r \text{ watts}$$

where

$K = 3.68 \times 10^{-11}$
C_r = coefficient of radiation of the radiating surface
T_p = temperature of radiating surface, Kelvin
T_a = temperature of surroundings, Kelvin
A_r = area of radiating surface in square feet

As stated above, the value used for C_r is 0.95. The area of one foot of pipe is π times the projected area stated above, or $\pi \times 0.552 = 1.735$ square feet. This neglects any blocking due to proximity of the other pipe. Substituting these values and recognizing that an ambient temperature of 35 C is 308 K, yields

$$H_r = 144 \times 3.68 \times 10^{-11} \times 0.95 \, [T_p^4 - (308)^4] \times 1.735$$
$$= 8.74 \times 10^{-9} \, T_p^4 - 78.6 \text{ watts per foot of pipe.}$$

CONVECTION

HEAT DISSIPATED BY CONVECTION is somewhat more complicated to evaluate, and, perhaps, more controversial. The Standard Handbook for Electrical Engineers[5] gives an equation in terms of the 1.25 power of the temperature differential. The recent paper by

House and Tuttle[2] gives some convection equations, one of them also involving the 1.25 power. Another equation, of some vintage, and which has been used with a degree of success on somewhat similar problems, is derived from a heating and ventilating book.[6] It gives terms in the first and second power of the temperature differential. Adapting it to the units used in this computation and assuming little breeze but not entirely stagnant air gives:

$$H_c = 0.527\,[f + S + 0.00416\,f\,(T_p - T_a)]\,(T_p - T_a)\,A_c \text{ watts}$$

where

f = a term for the prevailing conditions, which reduces to a value of 1.02
S = a term for the nature of the surface, which for painted pipe becomes 0.76
T_p = temperature of convecting surface, Kelvin
T_a = temperature of approaching air, Kelvin
A_c = area of convecting surface in square feet

Recognizing that T_a is the ambient temperature and that A_c is the same as A_r above, we get

$$H_c = 0.527\,[1.02 + 0.76 + 0.00416 \times 1.02\,(T_p - 308)]\,(T_p - 308) \times 1.735$$
$$= 0.003885\,T_p^2 - 0.766 T_p - 133 \text{ watts per foot of pipe.}$$

SOLUTION OF HEAT EQUATION

We now have all components of the heat balance, and can equate the heat input to the heat dissipated, obtaining an equation for T_p

$$H_i + W_i = H_r + H_c$$
$$42.4 + 18.0 = 8.74 \times 10^{-9}\,T_p^4 - 78.6 + 0.003885\,T_p^2 - 0.766\,T_p - 133$$
$$T_p^4 + 4.44 \times 10^9\,T_p^2 - 8.77 \times 10^9\,T_p - 31.1 \times 10^9 = 0$$

A root of this equation is readily found by graphical means at $T_p = 329.3$ K which corresponds to 56.3 C.

INTERNAL TEMPERATURE GRADIENT

The internal temperature gradient of the system may be calculated by recognized methods, not of especial moment to the present subject matter. For the steady-state conditions of the case under consideration this has been evaluated at 17.2 C from pipe to conductor. This, being directly additive to the pipe temperature, gives a conductor operating temperature of 73.5 C, a very close approximation to the 75 C design point. Any correction for the difference between this temperature and the value of 75 C assumed in determining the circuit losses would be much less than the accuracy of the solution.

Fig. 2. Cable pipes in approximate position on bridge before installation of individual mounting brackets.

CONCLUSIONS

There are a number of interesting inferences which can be drawn from the results obtained. First of all, the analysis yields a value which is substantially the design point of the system. This may be a fortuitous instance attending the initial trial. However, it can be said that none of the values selected for use, such as coefficients or other factors or operating conditions, were adjusted in advance to yield the answer obtained. As to the equations, the convection equation has been proven to a reasonable extent, as already mentioned, while the radiation equation is standard. The conclusion is that the analysis provides a reasonable basis for determining the external temperature gradient of the installation.

EFFECT OF INDIVIDUAL COMPONENTS

The fact that the heat received from the sun is approximately 2¼ times the heat due to system losses may be viewed with considerable interest. One is prompted to inquire whether it is not the major factor in establishing the 21.3 C rise of the pipe above the 35 C ambient. This cannot be judged by inspection from an equation which contains positive terms in the 4th and 2nd power of T_p and a negative term in the 1st power. To evaluate this situation, the equation was solved for each heat contribution alone. For solar radiation only, which would be the case of a de-energized circuit, the temperature rise was calculated to be 15.2 C. For no solar radiation, which would be the case of fully loaded operation of the circuit on a dull day, the temperature rise was calculated at 6.3 C. Their sum is 21.5 C, substantially the value of 21.3 C determined for their combined effect.

Thus, it may be concluded that in the range of temperatures involved and for the conditions of the problem as set up, the temperature differentials due to separate components of heat are substantially directly additive. Of further importance is the magnitude of the solar contribution, which for the case analyzed accounts for a temperature rise of the order of 15 C. Of course, we must recognize that the conditions assumed here are fairly severe, but it is necessary to assume severe conditions when analyzing design limits. To pursue this thought a little further, it is known that solar heat alone can raise surfaces to the "egg-frying" stage, if escape of the heat is sufficiently impeded.

ALUMINUM PAINT

Another item of interest is the result obtained for the use of aluminum paint. In this case, the solar ab-

sorption factor and the radiation emissivity factor are the same, both being 0.55.[3] Using this for C_s and C_r in the equation yields a pipe temperature of about 55.7 C, hardly different from that obtained for the transformer gray paint case. Thus, it may be concluded that for the case assumed, substitution of aluminum paint as the exterior finish of the pipe will neither improve nor impair performance.

GEOGRAPHICAL ORIENTATION

IT MAY ALSO BE OF INTEREST to note that in the latitude of New York City, pipes running north and south might be expected to run cooler than pipes runing east and west, inasmuch as solar radiation is such a dominant factor. The noon height of the sun never can be greater than that at the time of summer solstice. A pipe running north and south always will be inclined to the noon sun's rays by an angle corresponding to the difference between the latitude and the angle of amplitude of the sun's position for the date. The influence of this effect is diminished by the fact that at some time during the forenoon and afternoon the sun will impinge perpendicularly on a north–south pipe. At these times, however, the rays will suffer greater atmospheric absorption because of the lower altitude of the sun. For pipes in any other geographical orientation, the effect for the noon position is a simple elliptical function of the orientation. Thus, if a and b are the two diameters of an ellipse, such that a is the major diameter and b is the minor and is equal to a multiplied by the cosine of the angle between the zenith and the noon height of the sun, and θ is the angle of orientation of the pipe measured from an east–west position, then the solar radiation intensity will compare with that for the east–west orientation by the same ratio that the polar diameter of the ellipse for that orientation bears to the major diameter, which is

$$\frac{b}{\sqrt{a^2 \sin^2 \theta + b^2 \cos^2 \theta}}$$

This effect is discussed in the paper on ACSR by House and Tuttle.[2]

PROTECTION FROM SUN

ONE OF THE CIRCUMSTANCES which makes an installation of this kind different from an ordinary conductor problem is the dominant importance of heat from the sun. This is due largely to the large diameter of the enclosing pipe. The thermal barrier of the gas atmosphere inside the pipe tends to increase its importance by decreasing the margin available for temperature gradient within the cable. There may be cases where it might pay to provide a sun shield, arranged so as not to interfere with convection cooling. To be most effective, a sun shield should absorb as little heat as possible from the sun, should transmit a minimum through to the side facing the pipe, and should run as cool as possible. It will enter the heat balance as a source of radiation. In the case of nearby pipes, reflection from one sun shield falling on the other pipe should be guarded against.

Fig. 3. View of cable rig on bridge showing the three conductors ready for pulling. The pipe shown is the lead-in pipe, not the cable pipe.

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Thermal Wire

Winter shoppers at the Eastwood Shopping Center, near Pittsburgh, Pa., will be protected from the hazards of icy sidewalks by vinyl-insulated heating wires installed just below the surface of the walks.

Insulated with rugged Geon *8800*, a product of B. F. Goodrich Chemical Co., to provide protection from abrasion and corrosion, the heating wire will make sidewalk "salting" a thing of the past.

Called Chromalox Thermwire by the manufacturer, the Edwin L. Wiegand Co., Pittsburgh, Pa., the heating units are also designed to be used on roofs to prevent the formation of ice dams. The low cost and ease of installation makes it adaptable for use in business, industrial, or residential installations.

At Eastwood, circuit "loops" 190 feet in length were used. This heating wire was taped to ordinary reinforcing wire to prevent its displacement when the top layer of concrete was poured over it. The reinforcing wire was then placed on the sidewalk's sublayer where a ¾-inch concrete top layer was poured over it.

SSB/ISB Systems for Long-Distance Radiotelegraphy

WALTER LYONS

High-power single side band and independent side band transmitters together with their techniques augur the greatest growth possibilities since the inception of radiotelegraphy. This type of transmission will enable the industry to increase traffic at the same time that frequency occupancy is reduced. These are prime necessities with the upcoming low in the sunspot cycle.

SINGLE SIDE BAND (ssb) and independent side band (isb) radiotelegraph systems allow for a high degree of frequency division multiplexing as contrasted to the requirement for time division multiplexing in the usual frequency-shift keyed carrier systems. This advantage is the principal justification for its use, especially for those circuits requiring high-speed traffic handling capacities.

For the transmission of bit elements smaller than 10 milliseconds, the multipath delay distortion may be high to a degree that is intolerable for a commercial circuit. To reduce this distortion, it is required that the keyed pulse be "squared up," in other words, attain keying harmonics. This in effect forces the employment of large bandwidths of emission and reception. Thus, frequency conservation is defeated and power is wasted.

For smaller bit lengths, say under 5 milliseconds, it may be impossible to improve reception by the method of adding harmonics to the keying pulse. For this reason, it has been proposed to change the code arrangement from sequential bit information to simultaneous frequency-separated bits.

Simultaneous code presentation has the additional advantage in error-correcting equipment, where changes in code are usual, to reduce the amount and cost of equipment.

In the application of ssb for multichannel transmission, it is important to limit the peaks of modulation because of limited power available at this time from linear amplifiers. If the individual tone channels are keyed in an "on-off" manner, phase-locking these tones is sufficient to assure a small peak to average amplitude ratio. For frequency-shifted tone channels, other means such as compatible ssb may be employed. On the other hand, and for greater simplicity, increasing the number of these channels will reduce the time duration of high amplitude peaks and render them negligible.

Inasmuch as tone channeling on ssb transmission can be very accurately controlled and spaced because of the low audio frequencies used, frequency shifting at optimum values can be employed to obtain the highest effective power in the transmission bandwidth. In this way, over 40 teleprinter channels can be accommodated in a voice band at transmitter power levels well within present linear amplifier techniques.

Recent developments in transistorization and semiconductor devices greatly reduce heat dissipation, size, and weight of a great part of the ssb receiver, which is hardly possible under the older types. Due to these newer tools, maintenance is greatly reduced. The net result is the ability to expand operational circuits without the usual requirements for increase in personnel, building space, and real estate.

INTRODUCTION

THE APPLICATION of ssb techniques to point-to-point long-distance radiotelegraph communication circuits promises the greatest growth possibilities in this field since its inception. However, in order to realize the benefits to be derived, every advantage offered by ssb must be thoroughly exploited, and all devices which can reduce its shortcomings should be employed.

The advantages accruing to ssb working for point-to-point circuits at high frequency, as compared to ordinary carrier frequency shift (FSK) reside in economy in equipment and antennas, greater simplicity in operation, spectrum conservation, and power gain. The practical realization of economies in equipment depends upon adequate telegraph circuit traffic loading to justify the initial investment and change from the older FSK gear. Transmitted frequency spectrum compression and power gain go hand in hand and are the peculiar attributes of ssb, due to its inherent frequency stability because of carrier reference at audio frequencies. This is because the frequency-shifted channels being referred to the carrier are low audio frequencies, and problems in maintaining small shifts and accurate centers are far easier than at carrier shift frequencies.

SYSTEM SPECIFICATION

BEFORE FURTHER CONSIDERATIONS, it is appropriate to set forth the basic requirements for a commercial point-

Essentially full text of paper 59-1091, "Considerations in SSB/ISB Systems for Long Distance Radiotelegraph Communications," recommended by the AIEE Radio Communication Systems Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Fall General Meeting, Chicago, Ill., Oct. 11-16, 1959. Published in AIEE *Communication and Electronics*, Jan. 1960, pp. 921-24.

Walter Lyons is with RCA Communications, Inc., New York, N. Y.

The author is indebted to J. C. Hepburn, A. B. Bodonyi, D. S. Rau, E. D. Becken, and H. O. Peterson for their aid in the preparation of this article; and to the Tele-Signal Corp. for their co-operation in furnishing the photographs, Figs. 3 and 4.

to-point long-distance radiotelegraph circuit. They are that the circuit operate at least 95% of the time for 24 hours daily throughout the sunspot cycle, and that the error rate during operation of the path be less than 0.01%. To assure this performance, it has been determined empirically that about 5-kw input to a 13-db rhombic should be provided for each kilocycle emission bandwidth, assuming two and occasionally three frequency changes per day. This does not apply to circuits whose great circle paths go through the high absorption auroral zones.

IMPLEMENTATION

PRESENT PRACTICE in loading a 3-kc side band of an ssb transmitter with three time-division 4-channel multiplex aggregates thus will require 15-kw average power and 90-kw instantaneous peak envelope power. For a fixed bandwidth per tone channel the average radiated power required increases directly as the number of subcarriers, the peak power rising as the square. Clearly, means for limiting peak power are indicated in order that economic considerations do not decide against ssb working for this degree of traffic loading. Conventional means for limiting the peak r-f power, however, will result in an increase in spurious signal level with attendant signal degradation. There are two ways to remedy this situation. One would be to limit the modulation peaks, which requires, for minimum spurious output, a compatible ssb generator because the r-f envelope is a replica of the modulation input. The other way is to increase the number of input tone channels so that the duration of each peak is reduced to about 10% of a signal element. Assuming 10 millisecond signal elements, 1 millisecond peak duration is tolerable and indicates a minimum requirement for approximately six tone channels. The assumption is that all channels are not resting on fixed tones and channeling tones are 120 cps or more apart. This is a fortunate circumstance, since multipath delay distortion effects are not excessive when using a bit of at least 10 milliseconds. If the three

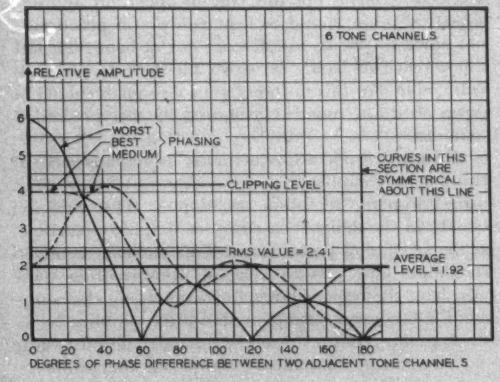

Fig. 1. Amplitude characteristic for six tones.

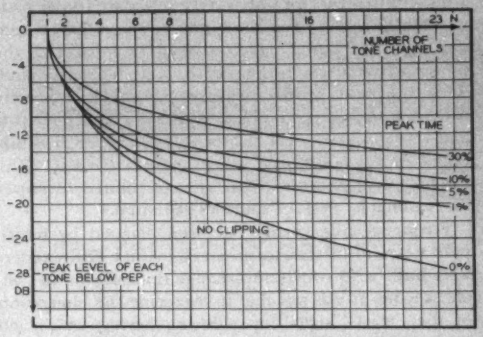

Fig. 2. Multitone levels for various clipping periods.

4-channel multiplex aggregates are split up into six diplex (2-channel) channels (12-teleprinter capacity), peak power will quadruple but chances are that the duration of any one peak will be short enough nearly to be negligible. The curves for various phasing conditions in Fig. 1 show that for 120-cps separation, clipping or limiting by the transmitter above the nominal peak level 4, the duration is 1.23 milliseconds. The value decreases as the tone separation increases. Fig. 2 presents the arguments for peak clipping of a large number of tone channels. The equivalent power gain due to clipping increases markedly with the number of tone channels. The percentage time of clipping is a measure of the degree of spurious radiation or distortion. For the 5% and smaller curves, no single peak duration exceeds 1 millisecond for most unfavorable tone phasing. For many subchannels, each being frequency-shift keyed, the instantaneous envelope amplitude approaches the probability density of a Rayleigh distribution. The expected distortion therefore will be considerably less than the curves indicate.[1]

A reduction in emission bandwith and consequent increase in effective power is now feasible, since at the reduced keying speed the transmitted pulse need not be trapezoidal for protection against multipath delay distortion. The transmission of a sine-wave-shaped signal element will serve to reduce interchannel cross-talk, allowing the use of filters having smooth cutoff characteristics with inherently low phase distortion. In this manner, a system may be devised to provide as many as 23 subcarrier frequency-shifted channels, each operated at diplex speed, accommodating 46 60-wpm teleprinters in a single ssb voice channel. Required parameters are a modulation index of 0.8 and subcarrier channel separation of 120 cps, starting at 300 cps and extending to 2,940 cps. A short-term traffic test of a portion of such system, as compared to the usual 4-channel multiplex (quad) channeling at 340-cps shift and 680-cps channel separation, has shown marked improvement in error rate. For the comparison, four diplexed channels and two quad channels were operated on an ssb voice channel. If now our interest is a circuit

with requirements for only twelve teleprinters, our total bandwidth from carrier need only be about 900 cps and our side-band power output roughly a quarter of the power required for full occupancy of the voice band. This is a power level which may be served adequately by linear amplifiers. In addition, heavily loaded circuits and those carrying services such as phone or facsimile might consider using "envelope elimination and restoration" ssb transmitters that are not limited in power for reasonable levels of spurious radiation.[2]

Frequency-shift keying has been plagued by multipath delay distortion to such extent that FSK exciters were built with switches to change transmission to "on-off" keying. It was possible to overcome the elongation of the "mark" signal by reducing keying weight on transmission. It is an unfortunate circumstance that misconception, due probably to frequency modulation broadcasting techniques, put the point-to-point radio communications systems on a wide shift basis. Perhaps also, in an attempt to overcome selective fading effects, the superimposed 200-cps phase modulation dictated the 850-cps shift even for solo channels.

There is considerable evidence on long-haul circuits to support the thesis that a reduction in shift reduces jitter. It may be that selective fading is reduced to such an extent that multipath delay tends to act equally on both "mark" and "space" frequencies. This should facilitate the reduction of distortion in the final signal by simple adjustment of the phase of inspection of the signal element, approaching in this manner an unbiased (equally biased) signal. Thus, the reduction in shift conforms to the characteristics of the keying mode—polar and unbiased, with attendant advantages in error reduction.

It is recognized that, in receiving signals with considerable multipath delay, wider filters will reduce the resultant jitter, but the reduction in frequency shift below 100 cps, serving to equalize the delay of both "mark" and "space" signals, allows for inspection closer to the trailing edge of the first received element, at the center of the unmutilated resulting bit. Including the increase in power attending the reduction in keying speed permitting sine-wave keying, the case for an FSK modulation index below unity is summarized.[3]

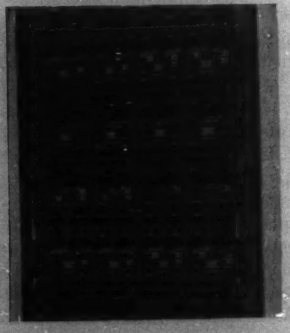

Fig. 3. Transmitter FSK subchanneling.

Ssb working can enable terminal equipment simplification by the facility for trading frequency division for time division multiplexing. Most error-correcting (ARQ) systems used in point-to-point radio communications at present employ the 7-unit Moore Code for error detection. This code invariably denotes a character by three mark and four space elements. Any deviation from this ratio is an error, calling for repetition by the sender. Most land-line traffic uses the 5-unit start-stop code, requiring, therefore, a code conversion device for operating into radio circuits protected by ARQ. For this purpose, it is required that information for each conversion be changed from serial code to simultaneous presentation of the code elements. By using separate tones each to denote an element of the sequential code, each such tone being keyed simultaneously for mark or space, simultaneous code presentation is effected very simply, resulting in equipment reduction and signal element elongation, if desired, without sacrificing traffic handling speed.[4]

Data handling other than regular message traffic should become, very soon, a major service on long-haul circuits. Accommodation of codes peculiar to specific data-handling systems can mean little more complication than adding additional tone channels for simultaneous keying. There is one pitfall, however, that must be avoided and which may be overlooked easily. The time delay in most filters and transfer lines varies with frequency. Steps must be taken, therefore, to assure equal delay for all the filters in a simultaneous code group, as well as the transfer line, over the frequency range of the group. This is an additional item of expense which must be included in an economic analysis of the two code types. Moreover, the need for equipment reliability in each of these tone chanels is far greater than in the equivalent for sequential keying.

The versatility in point-to-point services of isb working is a great economic argument for this mode. Assuming sufficient power, phone, facsimile, and many telegraph channels may be operated at the same time. These services may be handled at minimum bandwith occupancy, and should simplify frequency allocation by block assignment. For this type of operation, spurious signal radiation should be kept as low as is practicable, not alone to reduce interference out of band, but self-interference in band, to which facsimile is especially vulnerable. For this purpose, spurious signals should be down 30 db or more as measured by the standard 2-tone test.

Multiservice operation naturally is accompanied by equipment complication. Especially is this so when using diversity reception techniques. The situation breeds, in the designer, a desire to simplify—sometimes at the sacrifice of performance. This tendency is understandable, especially in view of pressure from those who have the responsibility for maintaining the equipment. One design example reduced the problem by divorcing the receiver from the so-called terminal gear (low-frequency equipment), installing the audio-frequency components in the central office. For large com-

mercial carriers, this has two shortcomings, one the expense of doubling control-line facilities for diversity reception, and the second putting an electronic maintenance load on an organization having little electronic experience. Diversity at the central office requires that the transfer lines have a very large dynamic range, otherwise fading signals drop into the noise level, suffering serious degradation.

Fortunately, recent developments in transistorization and semiconductor devices allow the possibility of very greatly reducing heat dissipation, size, and weight of receiver units, terminal equipment, and some transmitting units, at the same time effecting considerable circuit simplification. The net result is the ability to expand operational circuits without the usual requirement for expansion in personnel, building space, and real estate. Under such circumstances, it is questionable whether it is economical to consider automation in the form of direct control from the central office. It appears that a minimum personnel requirement at radio stations for maintenance and signal analysis can perform operating tasks as required without intruding on primary responsibilities. Extreme caution is indicated before application of servos and other schemes for automation lest we design in a requirement for greater human effort in maintenance and service.

Economy in space due to transistorization of transmitter channeling equipment is illustrated in Fig. 3 which shows a portion of an equipment rack. This is an assembly of 32 frequency-shift tone keyers (transmitters) and 32 tone-signal converters (signal demodulators), making a complete terminal facility for 32 FSK subchannels on ssb/isb transmission.

Fig. 4 is a complete assembly for tone-channel diversity reception, including a tone keyer for transmitting the received signal to the central office. The four separate units comprise two subchannel receivers and the diversity comparator between them, with the tone keyer on the extreme right.

Fig. 4. FSK subchannel diversity receiver and tone transmitter.

CONCLUSIONS

With the upcoming low in the sunspot cycle, frequency conservation will be a prime necessity. The availability of high-power ssb/isb transmitters, together with techniques outlined in the foregoing, enables the industry to increase traffic at the same time that frequency occupancy is reduced. Justification for changing over to ssb/isb might be the establishment of overseas trunk circuits or lorked operation to points close to the same azimuth.

The additional complications introduced require greater co-operation between correspondents than heretofore in operating simple carrier FSK. The establishment of standards should help, and efforts in this direction should be made soon to cope with what is expected in propagation within the next few years and beyond.

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3. Design Considerations for Frequency Shift Keyed Circuits, Walter Lyons. *RCA Review*, Princeton, N. J., June 1954.

4. U. S. Patent no. 2,183,147.

Gas Turbines for Venezuela

Clark Bros. Co., one of the Dresser Industries, reports that the fast growing acceptance of its Model *302* and *305* gas turbines are keeping production moving at a brisk pace.

Shown are several 8,700 and 9,300 bhp (brake horsepower) units on the Clark assembly floor in Olean, N. Y. Five of these dual-shaft turbines will be used by Shell Co. of Venezuela, Ltd. for its new gas-injection project on Lake Maracaibo, Venezuela, S. A. The units will be mounted on a platform over the water and will drive five Clark multistage centrifugal compressors. The entire plant is designed to handle approximately 190 million cubic feet of natural gas per day.

INSTITUTE ACTIVITIES

Attention AIEE Members

Why Read The Advertising?

READING the advertising is an up-to-date postgraduate course in many branches of the electrical industry. Advertising tells you who makes what, where, and why. New and improved principles of design are illustrated, and the attendant advantages explained. Product applications are described which may suggest other possible applications toward the solution of difficult problems. Finally, in some cases, the employment opportunities advertised may pave the way toward more gainful employment in accordance with your desires, inherent ability, and aptitude.

New Materials and Designs

As soon as new materials come out of the laboratories, their electrical, chemical, mechanical, and thermal properties are announced. These new materials are incorporated into designed apparatus and the attendant advantages such as improved quality, reliability, more compactness, higher efficiency and longer life, as well as new principles of design and methods of fabrication are explained. Whether it be a component, a diode, or a power tube, resistor or capacitor, the unit substation, or power apparatus, ranges of ratings and circuit characteristics are given in the advertisements often with references to additional literature for those who wish to study the products in greater depth.

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Specific control, computer, and apparatus applications are described leading to automation in industry. Reading the advertising can bring a trained electrical engineer to your door who may be helpful in solving baffling system design and operating problems.

Industrial advertising is prepared by trained experts who devote many hours to illustrating and describing new products in the clearest concisest form possible. The annual volume of advertising in business papers in 1959 has been estimated to be $555 million.[1] Some engineers are paid to read industrial ads[2] for the busy executive, the design, development, or applications engineer.

Read the advertising! Keep your postgraduate course up-to-date in the fastest manner possible. When making an inquiry, refer to *Electrical Engineering*.

1. *Printer's Ink*, November 6, 1959.
2. Based on a study, "Advertising to Industry," conducted by *Tide* in 1957-58.

Why Answer The Membership Survey?

DURING December, you were sent a membership survey with a threefold purpose: first, to obtain your correct name, address, and business affiliation for listing in the Membership Directory; second, to determine your business and industry classification, and occupation or function; third, to know your major and minor technical interests. If you have not already filled in and mailed your survey card, doing so may be well worthwhile.

Membership Directory

The correct listing of your name, address, and present business affiliation as well as whether or not you are a registered professional engineer is essential for a correct listing in the new Membership Directory.

Classification

To know your business and industry classification as well as occupation and function is essential to comply with the requirements of the Audit Bureau of Circulations (ABC). The nine business and industry classifications and seven occupation and functional classifications may not entirely meet all the situations of 54,000 members; nevertheless, it will be most helpful if you will list the classification which comes closest to your occupation and function. These classifications are not of our own choosing but must be on the same basis as those of competing publications under the requirements of ABC. The Audit Bureau of Circulations certifies to advertisers twice a year as to how many copies were paid for and to whom and where they go. A 100% return to this question will help bring to you more advertising along the lines of your interests and at the same time, enhance our income so that the publications may be of greater service to the members at the lowest possible cost.

Additional Services

In the last question, 50 different specialized areas of technical interests are shown. The indication of your major and minor interests will assure the receipt of announcements of special technical conferences in those areas of interest. To determine completely the specialized areas of interest of every member will also be helpful in several statistical studies toward long-range planning which will best serve your interests in the future. Response to this question in no way involves appointment to a committee or actual committee work.

If you have not already returned your membership survey card completely filled in for all classifications coinciding as closely as possible with your business and occupational functions, please take a few minutes to do so as promptly as possible.

The Editor

AIEE Prize Awards Announced for Presentation at Winter Meeting

RECOMMENDATIONS for seven Division Prize Awards were approved by the AIEE Prize Awards Committee at its meeting on December 1, 1959. Two Student Prizes also were awarded, in addition to a prize award in the classification known as General Committees and Articles in *Electrical Engineering*.

These Prize Awards will be presented February 1, 1960, at the General Session of the 1960 Winter General Meeting at Hotel Statler, New York, N. Y. The presentations will be made by AIEE President J. H. Foote, assisted by W. R. Harris, Prize Awards Committee chairman.

Division recommendations for Prize Paper Awards approved by the Prize Awards Committee are as follows:

Instrumentation Division

1st—Taut Band Suspensions for 250 Degree Instruments (Paper 59-159). *V. S. Thomander* (Member AIEE) and *R. C. MacIndoe* (Member AIEE), Westinghouse Electric Corporation.

In recognition of a very ingenious solution to the problems of designing for mass production a new concept in instruments which eliminates bearing friction, increases sensitivity by one order of magnitude, and achieves practical immunity to vibration and shock. The first taut band suspension adaptation to 250-degree scale instruments.

2nd—The Inductronic Electrodynamometer for the Precise Measurement of Voltage, Current, Power, and Energy (Paper 59-165). *R. F. Estoppey* (Member AIEE), Weston Instruments.

In recognition of a useful and clever adaptation of a principle that has been known for some time, with skillful and rather patient debugging to achieve performance of the Laboratory Standard Class.

Communication Division

No papers recommended.

Power Division

1st—Radio Noise Propagation and Attenuation Tests on Bonneville Power Administration, McNary-Ross 345-Kv Line (Paper 59-49). *G. E. Adams* (Associate Member AIEE), *T. W. Liao* (Member AIEE), *M. G. Poland* (Member AIEE), and *F. J. Trebly* (Member AIEE).

This paper presents valuable test data concerning radio influence characteristics of extra-high-voltage transmission lines necessary to check theory for use in calculating the performance of such construction.

Industry Division

1st—A Study of Nonlinear Systems with Random Inputs. *Kuei Chuang* (Member IRE) and *L. F. Kazda* (Member AIEE).

This paper provides an elegant solution in closed form to a particular class of nonlinear control problems, and justifies certain assumptions heretofore made in the approximate solutions of these problems

General Applications Division

1st—Solar-Powered Thermoelectric Generator Design Considerations (Paper 59-847). *N. F. Schuh* (Member AIEE), Westinghouse Electric Corporation, and *R. J. Tallent* (Associate Member AIEE), Boeing Airplane Company.

This paper concerns a subject of great current interest, the generation of electric power in space without fuel. Authors Schuh and Tallent make an orderly presentation of the problems and calculations involved in designing a solar-powered thermoelectric generator. The exposition is completed by the design calculations for a working model. The paper should stimulate additional work in this field.

Wear Your

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Science and Electronics Division

1st—The Stability and Compensation of Saturating Sampled Data Systems (Paper 59-52). *F. J. Mullin* (Associate Member AIEE).

The paper analyzes the stability of sampled-data feedback systems containing a saturating element, and establishes a necessary condition for stability of such systems; it also develops a procedure for design tools in this art; the material is well organized and clearly presented in elementary terms.

2nd—Shunt-Coupled Magnetic Amplifier

Philadelphia Section Committee

Photo-Arts

GENERAL COMMITTEE of the Philadelphia Section for the 1960 AIEE Summer General Meeting at Atlantic City, N. J., June 19-24, 1960, comprises the following: *(top row, left to right)* C. H. Rice, R. L. Halberstadt, R. C. R. Schulze, Section Chairman R. S. Hewett, T. M. Metz, R. T. Ferris, G. B. Schleicher, and W. P. Wills; *(bottom row, left to right)*—R. G. Lee, B. H. Zacherle, H. H. Sheppard, Committee Chairman S. R. Warren, Mrs. C. T. Pearce, W. R. Clark, and E. M. Callender. Members of the committee who were not present for the picture are: D. B. Smith, T. H. Story, A. E. Pringle II, C. S. Collier, D. L. Greene, and C. S. Dayton.

Circuits (Paper 59-635). *R. M. Hubbard* (Associate Member AIEE).

This paper deals with novel circuit arrangements and represents a definite contribution to the magnetic amplifier field. The author clearly states the purposes and advantages of these circuits, shows good physical reasoning in explaining their operation, and presents a number of typical examples which illustrate these concepts. A brief but complete analysis is also given. Finally, the paper exhibits good literary style in keeping with the high professional standards of the AIEE.

Student Prizes were awarded for the following two papers:

1st—A Telemetering System for Measuring Stomach Pressure in Animals. *R. Allington.*

2nd—A Narrow Band Peak Clipping Speech Amplifier. *R. Sommer.*

In the prize award classification known as General Committees and Articles in *Electric Engineering*, this prize was awarded to the following:

*Two Examples of Industrial Research in France Relating to the Transmission of Electrical Energy. *F. M. Cohen* and *R. A. Tellier.*

*This paper appeared in *Electrical Engineering* in two parts. Part I, entitled "Research in France which Established 380/420-Kv A-C System," was published in the April 1959 issue, page 320. Part II, "Submarine D-C Cable Interconnection between Great Britain and France," was published in the June 1959 issue, P. 664.

THIS CONTROL PANEL for a magnetic amplifier speed regulator was produced by the Allis-Chalmers Manufacturing Company. The company plant will be inspected during the Great Lakes District Meeting in Milwaukee, Wis., in April.

Controls To Be Subject of Great Lakes District Meeting

"Controls—Pearl Street to Cape Canaveral" will be the theme of the Great Lakes District Meeting in Milwaukee, Wis., on April 27-29, 1960. Co-ordinated with the technical papers will be plant inspection trips to the Allis-Chalmers Manufacturing Company, Square "D" Company, Line Material Company, Wisconsin Electric Power Company, and A-C Spark Plug Company. The technical papers and trips will convey in words and actual observations the control engineering influence in industry, utilities, communications, missiles, domestic appliances and machine tools, and also in rotating machinery.

Ross Photo

ABOUT NUCLEAR WAR: Dr. Herman Kahn (right) and Robert Panero (left) discuss their talk, "Nuclear Weapons and National Defense," with W. G. Vieth (second from left), chairman of the New York Section, AIEE, and R. S. Skinner, chairman of the Section's Communications Division, just prior to the joint Section-Division Meeting.

Joint New York Meeting Hears Talk on Nuclear Weapons

The Joint New York Section—Communication Division Meeting, held December 9, 1959, in the Western Union Auditorium, New York, N. Y., was addressed by Dr. Herman Kahn and Robert Panero on the topic, "Nuclear Weapons and National Defense."

Dr. Kahn—physicist, mathematician, economist, and author of a book on nuclear security, was the senior member of a team at Rand Corporation, New York, which looked into thermonuclear war and civil defense. Mr. Panero of Guy B. Panero Engineers, New York, served as consultant to the Rand team. Points covered by the two men in their presentation at the meeting included: the effects of nuclear testing on present and future generations, the effects of nuclear weapons of various power capacity, the effects of nuclear war on the country's food supply, military defense against a nuclear war, measures to avoid the possibilities of a nuclear war, and civil defense against a nuclear war.

Nine newly inaugurated Fellows of AIEE were introduced at the get-together which also included other activities of the annual New York Section Meeting.

Recognition was made of the AIEE

AIEE Future Meetings

Winter General Meeting*
Hotel Statler
New York, N. Y.
January 31-February 5, 1960

AIEE-IRE-U of P Solid State Circuits Conference*
University of Pennsylvania
Philadelphia, Pa.
February 10-12, 1960

Engineering Aspects of Magnetohydrodynamics Conference*
University of Pennsylvania
Philadelphia, Pa.
February 18-19, 1960

AIEE-IRE-AEC-NBS Scintillation Counter Conference*
Shoreham Hotel
Washington, D. C.
February 25-26, 1960

AIEE-ASME-I I of T American Power Conference*
Sherman Hotel
Chicago, Ill.
March 30-April 1, 1960

EJC Nuclear Congress
New York Coliseum
New York, N. Y.
April 3-8, 1960

Southwest District Meeting*
Shamrock-Hilton Hotel
Houston, Texas
April 4-6, 1960

Electrical Engineering in Space Technology Conference
Hotel Baker
Dallas, Texas
April 11-13, 1960
(Final date for †TP—closed, ‡CP Syn.—closed, CPMs—Feb. 8)

Materials Handling Conference
Sheraton Hotel
Philadelphia, Pa.
April 12-13, 1960
(Final date for †TP—closed, ‡CP Syn.—closed, CPMs—February 8)

East Central and Allegheny-Ohio Valley District Meeting
Daniel Boone Hotel
Charleston, W. Va.
April 12-14, 1960
(Final date for †TP—closed, DPMs —Feb. 5)

AIEE-ASME Railroad Conference
Penn-Sheraton Hotel
Pittsburgh, Pa.
April 20-21, 1960
(Final date for †TP—closed, ‡CP Syn.—Feb. 5, CPMs—Feb 15)

AIEE-ASME-IRE Automatic Techniques Conference
Sheraton-Cleveland Hotel
Cleveland, Ohio
April 18-20, 1960
(Final date for †TP—closed, ‡CP Syn.—Feb. 2, CPMs—Feb. 12)

Paper and Pulp Conference
University of Florida
Gainesville, Fla.
April 21-22, 1960
(Final date for †TP—closed, ‡CP Syn.—Feb. 5, CPMs—Feb 16)

Rubber and Plastics Conference
Sheraton-Mayflower Hotel
Akron, Ohio
April 25-26, 1960
(Final date for †TP—closed, ‡CP Syn.—Feb 10, CPMs—Feb 19)

Great Lakes District Meeting
Pfister Hotel
Milwaukee, Wis.
April 27-29, 1960
(Final date for †TP—closed, DPMs —Feb. 22)

North Eastern District Meeting
Sheraton Biltmore Hotel
Providence, R.I.
May 2-4 1960
(Final date for †TP—Feb. 2, DPMs —Feb 26)

AIEE-IRE-ACM Western Joint Computer Conference
Jack Tar Hotel
San Francisco, Calif.
May 3-5, 1960
(Final date for Initial Drafts—closed, Final Drafts—March 1)

AIEE-IRE-U of V Educational Frontiers in Biomedical Engineering Conference
University of Vermont
Burlington, Vt.
May 5-6, 1960
(Final date for TP—Feb. 5, ‡CP Syn.—Feb. 19, CPMs—March 1)

Spring Textile Conference
Georgia Tech
Atlanta, Ga.
May 5-6, 1960
(Final date for †TP—Feb. 5, ‡CP Syn.—Feb. 19, CPMs—March 1)

AIEE-IRE-EIA-WCEMA Electronic Components Conference
Washington, D. C.
May 10-12, 1960
(Final date for †TP—Feb. 10, ‡CP Syn.—Feb. 26, CPMs—March 7)

Farm Electrification Conference
Sheraton-Fontenell Hotel
Omaha, Nebr.
May 10-12 1960
(Final date for †TP—Feb. 10, ‡CP Syn.—Feb. 26, CPMs—March 7)

Annual Cement Industry Technical Conference
Pfister Hotel
Milwaukee, Wis.
May 17-19, 1960
(Final date for †TP—Feb. 17, ‡CP Syn.—March 4, CPMs—March 14)

AIEE-ISA-ARS-IAS National Telemetering Conference
Marimar Hotel
Santa Monica, Calif.
May 23-26, 1960
(Final date for †TP—Feb. 23, ‡CP Syn.—March 9, CPMs—March 18)

Summer General Meeting
Chalfont-Haddon Hall
Atlantic City, N. J.
June 19-24, 1960
(Final date for †TP—March 21, ‡CP Syn.—March 31, CPMs—April 15)

Pacific General Meeting
El Cortez Hotel
San Diego, Calif.
August 8-12, 1960
(Final date for †TP—May 10, ‡CP Syn.—May 20, CPMs—June 3)

Aero-Space Transportation Conference
El Cortez Hotel
San Diego, Calif.
August 8-12, 1960
(Final date for †TP—May 10, ‡CP Syn.—May 20, CPMs—June 3)

AIEE-ASME Engineering Management Conference
Morrison Hotel
Chicago, Ill.
September 14-16, 1960
(Final date for †TP—June 16, ‡CP Syn.—July 1, CPMs—July 11)

Fall General Meeting
Morrison Hotel
Chicago, Ill.
October 9-14, 1960
(Final date for †TP—June 10, ‡CP Syn.—July 21, CPMs—Aug. 5)

1961 Winter General Meeting
Hotel Statler
New York, N. Y.
January 29-February 3, 1961
(Final date for †TP—Oct. 31, ‡CP Syn.—Nov. 10, CPMs—Nov. 25)

*Final date for submitting papers—closed

†TP—Transactions Paper
‡CP Syn.—Conference Synopsis
CPMs—Conference Manuscript
DPMs—District Manuscript
(District Paper Synopses should be directed to the District Meeting Committee)

**Transactions and conference papers must conform to the requirements in *Author's Guide*
For a copy, write to E. C. Day, AIEE, 33 W. 39th St., New York 18, N. Y.**

Ross Photo

AWARD WINNERS of the inaugural prize paper competition held by AIEE District 3 in 1958-59 are pictured with J. R. Kerner (*right*), vice-president, at the joint New York Section—Communications Division Meeting. They are: (*left to right*) Irving Kolodny, A. Hauptschein, K. C. Morgan, G. S. Eager, Jr., Ludwik Jachimowicz, and D. E. Robinson.

District 3 1958-59 prize paper award winners. This was the initial prize paper competition held by District 3. First prize paper award winners, all associated with General Cable Corporation Research Laboratories, are: G. S. Eager, Jr., Ludwik Jachimowicz, Irving Kolodny, and D. E. Robinson. Second prize paper award winners, associated with the New York University Research Division, are: B. Harris, A. Hauptschein, K. C. Morgan, and L. S. Schwartz.

The first prize paper is entitled, "Transmission Properties of Polyethylene-Insulated Telephone Cables at Voice and Carrier Frequencies." The title of the second prize paper is "Binary Communications Feedback Systems."

W. G. Vieth, New York Section chairman, and recently retired chairman of Institute Committees also were recognized.

Ross Photo

NEW YORK SECTION members who were elevated to Fellow grade during the past year are shown with AIEE President J. H. Foote and Section Chairman W. G. Vieth at the Section meeting. Standing (*left to right*): A. C. Dickieson, R. F. Guy, H. B. Busignies, L. G. Abraham, Mr. Foote, and Solomon Fishman; and seated (*left to right*): E. J. Merrell, John Maszar, Mr. Vieth, R. W. Burrell, and W. K. MacAdam.

ASEE Publishes Guide for Recruitment of Graduates

A universally applicable guide for the recruiting of engineering college graduates has been published by the American Society for Engineering Education (ASEE).

Activities bringing together college graduates and would-be employers must meet four conditions, ASEE says:

1. To promote a wise and responsible choice of career.
2. To strengthen students' sense of integrity.
3. To develop in students an attitude of personal responsibility for their choice of career and for their success in it.
4. To minimize interference with education.

"It is in the best interest of students, colleges, and employers alike that the selection of careers be made in an objective atmosphere and complete understanding of all the facts," according to the ASEE guide. The 8-page leaflet lists in detail recommended practices and procedures by employers, colleges, and students to assure that these ends will be achieved.

"It is the hope of ASEE," according to Prof. W. L. Collins of the University of Illinois and secretary of the society, "that this leaflet gets into the hands of every engineering senior seeking employment, as well as recruiter, and college placement officers."

"It is designed as an aid in the development and maintenance of high ethical standards in the procedures of college recruiting and in the relations between the employing organization, college authorities, and college students."

This is the second revision of the original "code," first published in 1949; the current revision is entitled "Recruiting Practices and Procedures—1959."

W. W. Burton, employment manager of the Minnesota Mining and Manufacturing Company and chairman of the ASEE Committee on Ethics which was responsible for the publication, says, "This is a combination of the best thinking of representatives from both industry and education and represents the highest standards of ethical procedures yet developed. In its preparation, industry and education have had equal voices."

The Ethics Committee of the Engineers' Council for Professional Development (ECPD), the organization responsible for accrediting engineering curricula, again has endorsed the "code." Indeed, according to P. L. Alger, chairman of ECPD's Ethics Committee, this ASEE recruiting "code" now constitutes a supplement to the ECPD Canons of Ethics.

Copies may be purchased from ASEE at the University of Illinois, Urbana, for 10¢ each, 25 for $1, or $3 per 100.

Wear Your ◆ AIEE Badge

Richard Perrin Photo

PORT OF HOUSTON turning basin, terminus of a 50-mile deep-water channel that opened the doors of Houston to commerce with the world, is pictured. Three outstanding industrial plants situated on or near the channel will be toured by AIEE during the District 7 Meeting, while the waterway itself will be explored on a fourth inspection trip aboard the *MV Sam Houston*, the official port inspection boat. Since the *SS Satilla* warped-in at a waiting dock on August 22, 1915, the port has risen to second in the nation and has been a major factor in Houston's growth to the South's largest city.

Southwest District 7 Meeting Set for April 4-6, 1960, Houston, Texas

A TECHNICAL PROGRAM of unusual scope and interest awaits AIEE members who attend the Southwest District 7 meeting, to be held in Houston, Texas, April 4-6, 1960. Headquarters for the gathering will be the Shamrock Hilton Hotel.

Prominent speakers and personalities, comprehensive technical presentations, outstanding entertainment, and inspection trips to local industries will round out the interesting and informative program.

At the Monday morning general session, Houston Mayor Lewis Cutrer's welcome will be followed by Dr. J. A. Hutcheson's keynote address, keyed to the theme of the meeting—"Electricity—Pacemaker of Industrial Growth in the Great Southwest." Dr. Hutcheson is vice-president of Westinghouse Electric Corporation.

The technical program will include approximately 80 papers, presented in 4 simultaneous sessions during 5 half-day periods.

Inspection trips to some of the area's outstanding industrial installations will add variety and interest to the technical presentations. A tour through the Sam Bertron Steam Electric Generating Station, largest of the Houston Lighting & Power Company system, is scheduled, for Monday afternoon. Visits to the fully integrated steel mill of Sheffield Division Armco Steel Corporation, and to Southern Pacific's electronically operated Englewood Yard are scheduled the following day. Two boat trips down the industry-lined Houston ship channel on the official port inspection boat, the *MV Sam Houston*, are scheduled for Tuesday afternoon and Wednesday morning.

Entertainment for both members and their ladies has been carefully arranged. Tuesday evening's social hour and banquet will highlight the Lamar High School Mixed Chorus, a singing group noted for outstanding performances. Golfing plans have also been made for members wishing to relax with a game on one of Houston's sunny courses. Luncheon and a style show at a leading department store, together with social meetings each morning, will be of special interest to the ladies. In addition, they are invited to participate in the boat trips down the channel which terminate at the historic San Jacinto Battlefield.

Members will be mailed reservation blanks which should be completed and returned to the Shamrock Hilton Hotel. Early reservations are highly desirable, since the hotel will not guarantee to fill reservations received after March 26. Reservations may be made immediately by writing the Reservation Department, Shamrock Hilton Hotel, P. O. Box 1287, Houston, Texas, making reference to the AIEE District 7 meeting.

Special room rates obtained are as follows:

Accommodation	Rate
Single	$ 8-$18
Double	12- 20
Parlor and one bedroom	25- 40
Parlor and two bedrooms	55- 70

In the event the room requested is not

THE SHAMROCK HILTON HOTEL (*within* circle) in Houston, Texas, will be the headquarters for the Southwest District 7 Meeting of AIEE on April 4-6, 1960. Papers will be presented by 80 speakers who will cover 10 major fields of interest in a program keyed to the theme, "Electricity—Pacemaker of Industrial Growth in the Great Southwest." Inspection trips to local industries and entertainment for the ladies are additional program highlights.

COMMEMORATING the 75th anniversary of the AIEE in Schenectady, N. Y., were: (left to right) J. C. White, Schenectady Section chairman; L. C. Holmes, vice-president, Empire District; J. H. Foote, AIEE president; T. M. Linville, past director; and E. S. Lee, past president.

available, quarters having the next rate will be assigned.

Registration fees for the meeting are $4 for members, $7 for nonmembers, and $2 for ladies. Advance registration is urged, and preregistration forms and other correspondence should be addressed to: H. W. Magruder, General Electric Company, P. O. Box 22045, Houston 25, Texas.

Members of the AIEE District 7 Meeting Committee are: P. H. Robinson, general chairman; V. O. Clements. vice-chairman; J. B. Burr, vice-chairman; W. E. Silvus, budget and finance; M. T. Robin, co-ordinating secretary; C. L. McNeese, publicity; A. F. Williams, section liaison; L. K. Del'Homme, technical program; W. M. Oliver, hotel and equipment; C. M. Davis, registration and information; W. F. Strong and J. R. Ridgway, Jr., inspection trips and transportation; and G. B. Jamison, entertainment.

Schenectady Section Holds 75th Anniversary Dinner

The Schenectady Section, AIEE, commemorated the 75th anniversary of the Institute at a dinner held at the Edison Club in Schenectady, N. Y., on October 22, 1959.

The guest speaker, introduced by T. M. Linville, was J. H. Foote, president of AIEE. Mr. Foote spoke on "The Professional Engineer and His Technical and Professional Societies."

J. C. White, chairman of the Schenectady Section, presented, on behalf of the Institute, certificates of appreciation and accomplishment to a group of Schenectady area members upon the termination of their respective chairmanships of various national AIEE technical committees and subcommittees. Those who received certificates were: Mr. Linville, C. Concordia, I. B. Johnson, C. A. Woodrow, H. W Lord, L. W. Morton, F. J. Maginniss, A. G. Mellor, R. F. Shea, C. W. Frick, G. W. Heumann and Harold Chestnut.

C. P. Steinmetz an early president of AIEE, also served as the first chairman of the Schenectady Section which was organized January 1903. The Schenectady Section has contributed three other national presidents: E. W. Rice, Jr., (1917-18), D. C. Prince (1941-42), and E. S. Lee (1948-49).

Standards Evaluated at Control Systems Conference

The Control System Components Conference was held November 5-6, 1959, in Dallas, Texas, as a parallel effort with the National Automatic Controls Conference. The objective of the Control System Components Conference was to bring together component specifications people, system designers, and component designers. The theme of the conference was the "Evaluation and Review of Standards and Recommended Practices," with reference to components used in control systems.

The conference consisted of five half-day sessions.

Session No. 1—Transformers. The chairman was Reuben Lee. Three papers were presented on wideband transformers. The fourth item of the session consisted of a panel discussion by members of the AIEE Transformer Committee on the subject of the proposed AIEE Standard.

Session No. 2—Instrumentation. G. H. Bouman gave a presentation of the "Dynamic Response Testing of Process Controlled Instrumentation, Part I, General Recommendations, RP-26.1."

This session was sponsored by the Instrument Society of America (ISA). Mr. Bouman covered the subject of testing procedures as outlined in the Recommended Practices recently published by the ISA.

Mr. Bouman's paper may be obtained by writing to the ISA. Additional inquiries should be made to the chairman of the Dynamic Response Testing of Process Control Instrumentation Group, headed by Fred Winterkamp, E. I. duPont de Nemours & Co., Inc., Bell Works, P. O. Box 993, Charleston 24, Va.

Session No. 3—Magnetic Amplifiers. John Hart was the chairman of the session. A panel discussion covering the subject of the new "Proposed Test Code for Magnetic Amplifiers" was conducted. The panel consisted of R. M. Hubbard, H. W. Patton, F. G. Timmel, W. R. Seegmiller, and Dr. T. G. Wilson.

A copy of the "Proposed Test Code for Magnetic Amplifiers" may be obtained from the main office of the AIEE, or by referring to a recent issue of the AIEE *Communications and Electronics* magazine.

Session No. 4—Electrohydraulics. The chairman of the session was Dr. John Gibson. The main speaker was William Thayer, who reviewed the latest version of the proposed AIEE Standard on Electrohydraulic Servo Transfer Valves. Upon conclusion of this presentation, a question and answer period ensued. Copies of the Electrohydraulic Servo Control Valve Standard may be obtained by writing to Mr. Thayer, Moog Servocontrols, Inc., East Aurora, N. Y.

Session No. 5—Electromechanical. Chairman of the session was William Sollecito. A panel presentation reviewing the Society of Automotive Engineers' (SAE) "Aeronautical Recomended Practice" was given. The document, ARP 497, covering precision control motors, was presented by Dwight Bloser.

Mr. Bloser concluded the session by giving the status of the new proposed SAE Aeronautical Recommended Practice (ARP) Document covering the subject of tachometers. He predicted that this document would be released in approximately 16 months. A copy of the document, ARP 497, may be obtained by writing to the Society of Automotive Engineers, Inc., 485 Lexington Ave., New York 17, N. Y.

Support the New United Engineering Center

First Conference on AIEE's Role in Space Technology Is Planned for April

THE DEVELOPMENT of AIEE's interests in space science and the specific areas of electrical engineering where it should lend support will be the subject of the first conference on Electrical Engineering in Space Technology, to be held at the Baker Hotel, Dallas, Texas, April 11-13, 1960, in collaboration with the Institute of Radio Engineers and the American Rocket Society.

The purpose of the conference and AIEE's future contributions to space problems is formally set forth by the following statement endorsed by the Institute:

Statement of Purpose

The impact of the scientific and technological endeavor related to the national and international effort in the exploration and exploitation of outer space, together with the scope and difficulty of attendant problems, is recognized by the Institute. Accordingly, it endorses and encourages an intensified effort on the part of the Institute toward defining and fulfilling its professional responsibilities and its appropriate role of leadership in space technology.

A vast resource of background knowledge and know-how in electrical science and engineering exists within the Institute, fertile for extension and application to the solution of space problems, and potentially accessible to affiliated areas in space technology.

Electrical aspects of space technology have become increasingly significant in fields of aero- and astrodynamics, propulsion, metallurgy, and atomic and solid-state physics. Simultaneously, those working in these fields have become aware of this new significance of electrical science and engineering. There is need, therefore, to utilize the existing capabilities of those working in electrical science and engineering in solving space problems, and for electrical engineers to collaborate with scientists in these fields in solving problems in communication, navigation, energy, and control.

***SPACE REQUIREMENTS will be stressed at the initial Conference on Electrical Engineering in Space Technology, which will be held April 11-13, 1960, at the Baker Hotel in Dallas, Texas.**

This first, or kick-off, conference will stress space requirements on the one hand, and the capabilities in electrical science and engineering on the other. The two-and-a-half day program will encompass orientation and problem areas by authorities working in space research and development, and discussions of developments in four principal fields:

1. Communications
2. Feedback Control
3. Electric Energy Conversion
4. Instrumentation.

Sessions are planned to cover the following themes:

Monday, April 11

Morning Session

"A Glimpse at the National Space Picture," consisting of orientation talks by civilian and military leaders in the space program.

Lunch

A luncheon talk is planned for presentation by a member of Congress on recent congressional committee activity.

Afternoon Session

"The Space Age Viewpoint on the Fields of Communication, Control, Electric Energy, and Instrumentation," with papers by scientists active in these fields.

Dinner

"Adventures in Space Science (Fiction)," to be presented* by a prominent speaker with an avocation in science fiction writing.

Tuesday, April 12

Morning Session

"Specific Missions, Requirements, and Problems of Some United States Missiles and Space Vehicles and Payloads."

Afternoon Session

"Developments in the Fields of Communications, Feedback Control, Electric Energy Conversion, and Instrumentation," presented by electrical engineers representing these areas. Immediately following, a seminar is planned entitled, "Basic Electrical Engineering Materials, A Review," treating magnetics, insulation, and solid-state materials.

Wednesday, April 13

Morning Session

"Developments in Equipment and Component Capabilities for Space Application," which will be divided into four separate sessions, each treating one of the four major fields highlighted in the conference: communications, feedback control, electric energy conversion, and instrumentation.

*This illustration by Frank Tinsley is reprinted from *Industrial Research* magazine and the book, "Stimulus," both published by Scientific Research Publishing Company, Inc.

AIEE members and affiliates have been urged to support the purpose of this conference in view of the national and international scope and importance of space problems. Almost all papers will be invited. However, those wishing to contribute papers for the conference, appropriately within the scope of the session themes, should address their correspondence to: B. J. Wilson, Code 5230, U. S. Naval Research Laboratory, Washington 25, D. C.

Personnel for the conference comprises: general chairman—B. J. Wilson, Washington, D. C.; local arrangements chairman—E. Lipscombe, Dallas, Texas; finance—H. L. Reynolds, Dallas; registration—C. F. Crandall, Dallas; hospitality—J. Cupples, Dallas; publicity—D. Coffman, Dallas; facilities—J. Turpin, Dallas; and technical program committee—B. J. Wilson, chairman; E. D. Becken, New York, N. Y.; E. Brancato, Washington, D. C.; R. D. Campbell, New York; R. E. Horn, Baltimore, Md.; J. G. Lundholm, Los Angeles, Calif.; W. E. Phillips, N. Wales, Pa.; D. Talley, New York; and J. G. Truxal, Brooklyn, N. Y.

Telemetry in Industry and Defense Is Theme for 1960

The National Telemetering Conference, currently sponsored by four professional societies having a mutual interest in telemetering—AIEE, Instrument Society of America, Institute of Aeronautical Sciences, and American Rocket Society—will be held May 23-25, 1960, at the Hotel Miramar, Santa Monica, Calif.

Each year, the organization of the conference is rotated among these societies. The host society for the 1960 conference is the Instrument Society of America. The theme this year is "Telemetry—A Tool of Industry and Defense."

The basic objectives of the conference are to furnish a common ground for exchange of technical information, to stimulate development progress, and to document the year-to-year progress in the constantly expanding field of telemetry.

Papers submitted for presentation at this conference should be related to the theme while contributing to the basic objectives of the conference.

The tentative technical program follows:

Monday, May 23

Session I. Industrial Data Transmission Systems
Session II. Biomedical Measurements
Session III. Space-Data-Acquisition Systems
Session IV. General R-F Components and Techniques
Session V. Missiles and Aircraft Telemetry Workshop—"R & D Needed in the '60s."
Session VI. Data Processing and Presentation

Tuesday, May 24

Session VII. Industrial Process Control
Session VIII. General—Transducers
Session IX. Ground Stations—New Components and Techniques
Session X. Industrial Supervisory Control
Session XI. Missiles and Aircraft—Flight Data Systems

Session XII. Space-Data-Transmission Techniques

Wednesday, May 25

Session XIII. Industrial—Data Processing and Display

Session XIV. Missiles and Aircraft—Environment Measurement and Control

Session XV. General Transistorization Progress

Session XVI. Industrial Telemetry Workshop—"What We Really Need Is—"

Session XVII. Special Telemetry Techniques

Session XVIII. Reliability in Telemetry

The foregoing are the general topics toward which the program is slanted. The session titles may undergo revision.

March 15, 1960, is the date when final papers may be submitted to the national program chairman.

The close-off date for final submission of papers has been set in order to permit preprinting and binding of papers in time for issuance to attendees at the conference upon registration. Blanks will be provided all authors for typing the completed paper in accordance with the desired printing format, along with complete instructions well in advance of the final submission date.

Publicity relating to the technical program or any publicity pertinent to the conference may be submitted to: R. W. Murray, 15016 Ventura Boulevard, Sherman Oaks, Calif.

PLANS for the 1960 Rural Electrification Conference were made at a meeting of the conference committee on September 1, 1959. Attending were *(left to right, seated)*: H. E. James, General Electric Company, inspection trip chairman; J. L. Trebilcock, Fairbanks, Morse & Company, publicity chairman; W. J. Ridout, Jr., *Electricity on the Farm*, general chairman; Ralph Shaw, Omaha Public Power District, vice-chairman of the Nebraska Section; C. R. Putzier, Westinghouse Electric Corporation, Nebraska Section vice-chairman; *(left to right, standing)*: J. G. Ekstrand, Consumers Public Power District, finance; C. R. Hendrickson, Omaha Public Power District, finance chairman; R. E. Kelly, Westinghouse Electric Corporation, hospitality chairman; Max Mattison, Nebraska Public Power System, publicity; L. C. Shalla, Omaha Public Power District, registration chairman; and I. O. Sunderman, Consumers Public Power District, meeting facilities chairman.

Electric Farming Conference Scheduled for May 10-12, 1960

The theme of the 1960 AIEE Rural Electrification Conference, scheduled for May 10-12, in the Sheraton-Fontenelle Hotel, Omaha, Nebr., will be "The Challenge of Electric Farming."

Papers presented during the conference will point out the demands for electricity by all phases of agriculture. A discussion will be held on how the electrical industry—power supplier, manufacturer, and distributor—is meeting this challenge.

Agricultural equipment manufacturers and power suppliers have been invited to send representatives to the conference.

Tentative arrangements have been made for tours through the headquarters of the Strategic Air Command, the Omaha Stock Yards and Packing Plants, and Father Flanagan's "Boys Town."

Preliminary plans for the conference are being made by the AIEE Nebraska Section committee in Omaha, under the direction of Ralph Shaw, conference chairman, and W. J. Ridout, Jr., general chairman.

PARTICIPATING in the 11th Annual AIEE Machine Tool Conference were: *(left to right)* R. S. Gardner, AIEE headquarters, New York; E. C. Barnes, chairman of the Cleveland Section, AIEE; D. C. Romick, Goodyear Aircraft Corporation; E. J. Loeffler, chairman of the Machine Tools Subcommittee, sponsor of the meeting; and N. P. Bashor, vice-chairman and chairman-elect for next year.

New Developments Covered at Machine Tool Conference

About 550 representatives of machine and control manufacturers attended the 11th Annual AIEE Machine Tool Conference on October 19-21, 1959, at the Sheraton-Cleveland Hotel in Cleveland, Ohio.

Several relatively new adjustable speed drive systems were presented. The latest developments in static control systems and several new control accessories also were covered.

At the luncheon on Tuesday, October 20, the speaker was D. C. Romick, internationally known aerophysicist with the Goodyear Aircraft Corporation. Mr. Romick's illustrated lecture was entitled "Dawn of the Age of Space Flight." He discussed many of the plans and problems involved in space exploration.

Biomedical Electronics Described at Joint Conference

The 12th Annual Conference on Electrical Techniques in Medicine and Biology which was attended by more than 500 specialists in this field was sponsored by AIEE, Institute of Radio Engineers, and Instrument Society of America in Philadelphia, Pa., November 10-12, 1959.

Biomedical electronics was given momentum with the application of an increasing number of current electronic techniques to the problems of medicine and biology.

The use of electronics in this field is growing "slowly, but systematically, and on a solid base," according to Dr. H. P. Schwan, Electromedical Division, Moore School of Electrical Engineering, University of Pennsylvania, and chairman of the conference. This view was supported by the number of new electronic techniques described to the delegates in 40 technical papers.

Among the exhibits shown during the conference were: an instantaneous particle counter, a Varichron electronic timing unit, a Fluoremeter, a differential electrometer amplifier, a direct recording Visicorder oscillograph, and Metrohm equipment for blood pH.

AT THE OPENING of the 12th Annual Conference on Electrical Techniques in Medicine and Biology, November 10-12, 1959, in the Hotel Sheraton, Philadelphia, Pa., were: *(left to right)* **H. P. Schwan, conference chairman, and J. H. Foote, AIEE president.**

I. S. Coggeshall Manages Technical Operations Services

I. S. Coggeshall (M '37, F '48) joined the AIEE headquarters staff as manager of Technical Operations Services on January 1, 1960, following his retirement as assistant vice-president, International Communications, Western Union Telegraph Company. He has been active in electrical communication affairs in the AIEE, having been secretary of the Communication Group, New York Section, upon its organization in 1930, and later its chairman. His other committee service includes: Communication (1943-47); Telegraph Systems (chairman 1949-51); Communication Division (1950-59, chairman 1955-57); Technical Operations (1955-57); Technical Operations Department (1957-59, vice-chairman 1959); and Board of Examiners (1952-56, chairman 1954-55). He has also been a director, and in 1951, president, of the Institute of Radio Engineers.

Dr. Coggeshall attended Worcester Polytechnic Institute, was elected to Tau Beta Pi, and later was awarded an honorary degree of doctor of engineering by Worcester for achievement in the submarine cable field. He has been registered as a professional engineer in New York State since 1937. He saw naval service in both World Wars; was executive officer of the U. S. Naval Communication Reserve, 3rd Naval District, New York, 1938-40; and retired as Commander, USNR, in 1957. His writings, in AIEE publications, the "Encyclopaedia Britannica," and elsewhere have covered the business as well as the technology of radio and wire communication.

As manager of Technical Operations Services, Dr. Coggeshall will be responsible for staff services related to the work and program of the Technical Operations Department and its 6 constituent Divisions and 56 Technical Committees. Other members of the Technical Operations Services staff are E. C. Day, in charge of papers and meeting programs, and R. S. Gardner, in charge of technical activities including the 3 dozen Special Technical Conferences sponsored in whole or part by AIEE.

Expansion of the department's services is anticipated in the areas of new activities, local and national technical groups, and extended opportunities for member participation.

I. S. Coggeshall

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EJC Manpower Commission Reports on Need for Engineers

Industrial recruiting and the over-all demand for engineers increased materially in 1959.

Acute numerical shortages were not widespread because of the large number of engineering graduates available for immediate employment. In 1959, there were 38,162 B.S. graduates in engineering, the largest class since 1951, 36% greater than in 1956, and 41% over 1955—the period in which shortage was most acute.

The demand for engineering graduates will increase and by 1966 there will be 15 graduates recruited for every 10 hired in 1959.

Starting salaries are at an all-time high, averaging $510 monthly for B.S. graduates, $600 for M.S. graduates, and $825 for Ph.D.'s. Aircraft, electric equipment, and electronics industries offered the highest salaries.

These are the facts on supply and demand for engineers, made public recently by the Engineering Manpower Commission of Engineers Joint Council (EJC) in its ninth annual report entitled "Demand for Engineers—1959."

According to the report, the downward trend in the demand by industry and government for engineers has been sharply reversed from that prevailing in 1958, when there was a close supply-demand balance. This, however, was due to the temporary recession in the economy and did not affect the absolute demand for engineers, which is constantly growing with the expanding economy over the years.

The report warns that, as the economy continues to expand, numerical shortages of engineers again may be present because enrollments in engineering schools in 1958 and 1959 have declined.

The report states that engineering turnover in 1958 averaged 9.5%, a decline over 1957 (11%) and is expected to drop to 8.6% in 1959. The principal cause for losses is resignation (55%), followed by death and retirement (9%), and military leave (6.5%).

It also points out that demand for engineering technicians in 1959 also increased over 1958. Industrial employers expected to hire in 1959 one additional technician to every 10 now employed, while in-plant training of additional technicians also corresponds to about 10% of the employed number.

As to future demand, the report shows that industrial demand, or recruiting, in terms of gross additions was 13.4% in 1959; it is expected to rise to 15.2% in 1960, 17.1% in 1963, and 20.6% in 1966. This reflects anticipated continuing expansion of needs for engineering graduates, particularly for new graduates. These trends vary from one industry to another. The most accelerated growth is expected to be in research and development, aircraft, electric equipment and electronics, machinery, and mining. The rate of additions of engineering manpower is expected to be below industry average in construction, railroads, utilities, and chemicals.

The report on "Demand for Engineers—1959" is available from the Engineering Manpower Commission, 29 W. 39th St., New York 18, N. Y.

Reclamation Engineer Is Awarded District 6 Prize

J. E. Skuderna, electrical engineer with the U.S. Bureau of Reclamation, Denver, Colo., recently was awarded first prize by the judges of District 6, AIEE, in the AIEE annual prize paper contest. The prize consists of a certificate and cash award of $75. District 6 comprises all of Colorado and Nebraska, and portions of Wyoming, South Dakota, and Iowa.

The presentation was made by M. H. Kight, chief of the Electrical Branch of the Bureau of Reclamation, Denver, Colo., and national vice-president (District 6) of the AIEE. Mr. Skuderna is presently treasurer of the Denver Section of the Institute.

Mr. Skuderna presented his paper, dealing with the "X/R Method of Applying Power Circuit Breakers," at the Winter General Meeting of the Institute in New York City in February 1959.

Membership in the American Institute of Electrical Engineers, including a subscription to this publication, is open to most electrical engineers. Complete information as to the membership grade, qualifications, and fees may be obtained from Mr. N. S. Hibshman, Secretary, 33 West 39th Street, New York 18, N. Y.

Combined District Meeting Planned

COAL, CHEMICALS, AND POWER sessions will be featured at the combined East Central and Allegheny-Ohio Valley District meeting to be held April 12-14, 1960, in Charleston, W. Va. The District Committee which is making plans for the combined meeting has been active since October 1958. Committee members pictured above are: (left to right) R. H. Hively, J. E. Dennis, M. H. W. Illing, W. C. McMahan, L. M. Roth, Chairman C. M. Hunt, B. W. Whittington, P. W. Sinsel, Z. C. White, J. C. Norton, and H. L. Austin.

Work Has Started

EXCAVATION has begun on the site of the new United Engineering Center at the United Nations Plaza, New York, N.Y. In the background, the United Nations buildings may be seen.

AIEE FELLOWS ELECTED

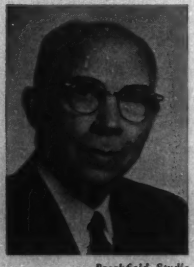
Board of Directors Meeting, November 19, 1959

Ralph Hilliard Earle (AM '27, M '29, Member for Life), manager of engineering development, Line Material Industries Division of McGraw-Edison Company, South Milwaukee, Wis., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to development of equipment for electric distribution." He was born December 18, 1894, at Newton, Kans., and graduated in 1917 from the Armour (now Illinois) Institute of Technology with the degree of B.S. in electrical engineering. After a few months as an assistant engineer in the test department of the Atchison, Topeka & Santa Fe Railway, Topeka, Kans., he went to work for Cutler-Hammer, Inc., Milwaukee, Wis., as an engineer on development of measuring instruments used in the gas industry. During 1920-29, he was employed by Allis-Chalmers Manufacturing Company as an engineer in the hydraulic turbine department. In 1929, he joined the Line Material Company, now a division of McGraw-Edison Company, as head of the newly formed research department and was later appointed director of research. In 1949, he was advanced to manager of engineering, general products, which comprised outdoor lighting equipment and protective equipment, capacitors, and construction materials for outdoor electric distribution systems. He became manager, engineering development, in May 1959. Mr. Earle holds 35 United States and 18 Canadian patents for inventions which included supervisory control equipment for hydroelectric generating stations, welded steel plate construction for heavy hydraulic machinery, and high-voltage distribution equipment for outdoor electric power systems. He is a member of Eta Kappa Nu, Tau Beta Pi, the American Standards Association, the National Electrical Manufacturers Association, the Wisconsin Society of Professional Engineers, and the Engineers Society of Milwaukee, of which he is a past president. He is a registered professional engineer in the State of Wisconsin. Mr. Earle is a past chairman of the Milwaukee Section, AIEE, and served on the AIEE Protective Devices Committee (1947-51).

George H. Groh (M '43), vice-president in charge of research and planning, Arizona Public Service Company, Phoenix, Ariz., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to the development of a rapidly expanding electric power system." Mr. Groh was born January 17, 1901, in Myerstown, Pa., and received the B.S. degree in electrical engineering from Penn State College in 1923. During 1923-29, he was employed by the West Penn Power Company, Pittsburgh, Pa. He was assigned to various operating and maintenance positions, to relay work in the engineering department, was advanced to test engineer, and handled operating department functions. He joined Public Service, then the Central Arizona Light & Power Company in 1929. He handled assignments in the engineering department and was assigned to new steam plant construction early in 1930 as electrical installation co-ordinator. After placing the plant in operation, he returned to the engineering department. In 1930, he was placed in charge of the electric and gas meter departments, and in 1933, he was assigned to valuation study and assembling of exhibits in preparation for rate hearing. During 1934-37, he assisted in natural gas conversion and was then assigned to the commercial and industrial sales department as sales engineer. In 1936, he became commercial and industrial sales manager. He was later assistant general superintendent in the operating, maintenance and construction departments. In 1944, he had advanced to general superintendent; in 1945, chief engineer and general superintendent; and in 1948, he was elected vice-president in charge of operations. Mr. Groh was vice-president and assistant to the executive vice-president during 1953-59, until he became vice-president and manager of research and planning, the position he now holds. During World War II, he was a member of the Pacific Southwest Power Pool Co-ordinating Committee for directing power to best use in the war effort. He was on the Arizona Section AIEE Executive Committee (1950-51), and was chairman of National Engineers Week in Phoenix in 1959. Mr. Groh is a registered professional engineer in the State of Arizona, a member of the National Society of Professional Engineers, and served on the AIEE System Engineering Committee (1948-49).

Howard Martin Hess (AM '35, M '46), associate dean of engineering, Wayne State University, Detroit, Mich., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to the organization of electrical engineering education." He was born September 11, 1908, in Akron, Mich., and attended Wayne State University, while it was yet a municipal institution. Previous to his entering Wayne, he worked at the Western Electric Company for 3 years on the installation of some of the first dial telephone central office equipment in Detroit. Immediately after graduation, he began teaching in the electrical engineering department at Wayne University and has continued there since, except for a period of study at the University of Michigan, where he received the M.S. degree in electrical engineering in 1937. He did further graduate work at the State University of Iowa in 1940-41. Mr. Hess took an active part in the development of the curriculum and the laboratories of the new electrical engineering the area of power circuits and machinery, the area of power circuits and machinery. He became acting head of the department in 1945, and in 1948 was appointed head of electrical engineering, a position he held until his present appointment in 1957. During the years 1941-45, Mr. Hess was responsible for all the physical facilities of the extensive war training program carried on by Wayne University. In 1944, he helped organize the Wayne Engineering Research Institute, served as secretary-treasurer of the corporation for 4 years, and remained on the Board until the Institute, having served its purpose, was dissolved in 1957. He has been a director of the Michigan Section, AIEE, for 13 years and was chairman of the Section in 1957-58. He is a member of the American Society for Engineering Education, the Engineering Society of Detroit, the Institute of Radio Engineers, Eta Kappa Nu, Omicron Delta Kappa, Sigma Xi, and Tau Beta Pi. He has served on the AIEE Sections Committee (1958-60) and Student Branches Committee (1958-60).

Harold Edgar Houck (M '40), senior electrical engineer, E. I. du Pont de Nemours & Co., Inc., Wilmington, Del., has been



Brookfield Studio

R. H. Earle

Botsford Studio

G. H. Groh

H. M. Hess

H. E. Houck

M. A. Hyde, Jr.

Fabian Bachrach

H. A. Leedy

C. C. Saunders

D. F. Tuttle, Jr.

transferred to the grade of Fellow in the AIEE ". . . for contributions to the electrical aspects of industrial, chemical, and nuclear projects." Mr. Houck was born in Reading, Pa., on December 18, 1899. After studying electrical engineering at Pratt Institute, he entered the student engineering training program of General Electric Company, Schenectady, N. Y., in 1923. He joined the Victor Talking Machine Company, Camden, N. J., in 1925 as assistant electrical engineer. Later that year, he entered the employ of Du Pont as an electrical designer and has since then served continuously in the Du Pont engineering department. As electrical engineer, he was responsible for some of the early applications of mercury arc rectifiers to large electrochemical installations in the United States. During World War II, as senior electrical engineer, he directed the electrical design activity for a number of ordnance and chemical plants built by Du Pont for the U.S. Government. Later, he participated in the design of the Hanford Engineer Works. He was responsible for the administration and co-ordination of all design of the electrical and control aspects of industrial, chemical, electrochemical and explosive plants averaging $50 million per year in value during 1928-54. During 1945-50, he was responsible for the electrical design on a number of Du Pont chemical plants. In 1950-54, he directed all electrical design activity for the Dana and Savannah River Plants that Du Pont designed, constructed, and operated for the Atomic Energy Commission. During 1954-59, he supervised the activity of a group of electrical consultants in the Engineering Service Division of Du Pont. From April 1959 to the present, he supervised the electrical effort on the Savannah River Plant design. He is a registered professional engineer in the State of Delaware. Mr. Houck has served on the AIEE Chemical Industry Committee (1947-52, 1954-60) and Electronic Power Converters Committee (1947-49).

Merritt Anderson Hyde, Jr. (AM '27, M '45), advisory engineer, Westinghouse Electric Corporation, East Pittsburgh, Pa., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to electrical application and pipeline pumping." Mr. Hyde was born July 1, 1896, in Owego, N. Y. He studied at Marietta College, received the B.S. degree in electrical engineering from the Case Institute of Technology in 1922, and the electrical engineering degree from Case Institute in 1944. He was awarded the honorary Sc.D. degree from Marietta College in 1948. From July 1922 to the present, he has been engaged continuously by Westinghouse. Upon completion of graduate student training with the firm, he entered the general engineering department, where his work has been in the industrial electrification field. He held the positions of engineer, senior engineer, and fellow engineer until he was advanced to his present position, in which he is a leading consultant and application engineer in the pipeline branch of the petroleum industry. During 1923-30, he specialized in cement and ceramics industries in the Westinghouse General Mill Engineering Section. He was a consulting and application engineer on electrification of buildings and public works in 1931-35. He was consulting and application engineer on chemical and petroleum industries in 1935-59. He served as electrical consultant on the Plantation Pipeline project during 1941-43, 1950-51, and 1954. As consultant to Trans Arabian Pipe Line, in 1950, he collaborated on the electrical control system for diesel powered pumping stations and, in 1957, on master control for local and remote operation of gas-turbine driven pump units. He was a consultant to Westinghouse in the development of electrical control systems for gas turbines in pipe line applications involving both local and remote operation. He directed Westinghouse engineering for numerous remotely controlled electrically powered pump stations in the United States and abroad. He co-ordinated Westinghouse engineering on complete electric equipment and speed-increasing gears for five electrified compressor installations on the gas line of Texas Eastern Transmission Corporation. He is a registered professional engineer in the State of Pennsylvania. He is a member of the American Petroleum Institute, Phi Beta Kappa, Tau Beta Pi, Eta Kappa Nu, and Sigma Xi. Mr. Hyde has served on the AIEE Chemical, Electrochemical, and Electrothermal Applications Committee (1947-54); Petroleum Industry Committee (1954-60, chairman 1959-60); and Industry Division Committee (1959-60).

***Haldon Arthur Leedy** (M '46), executive vice-president and director of the Armour Research Foundation of the Illinois Institute of Technology, has been transferred to the grade of Fellow in the AIEE ". . . for contributions to the organization and administration of an engineering research center devoted to community betterment." A native of Fremont, Ohio, Dr. Leedy was born April 15, 1910. He studied physics at North Central College, Naperville, Ill., and at the University of Illinois, Urbana. After completing work toward his doctorate, Dr. Leedy joined the Armour Research Foundation in 1938 as a physicist. In 1944, he was advanced to chairman of the physics research department, and 2 years later he assumed the directorship of the Foundation. In 1950, he was named vice-president. Since 1950, he has exercised administrative control of the Foundation as a whole. Growth under his direction has been from an annual gross research volume of about $3.5 million to $14 million and from about 650 to 1,265 employees, of which 855 are professional personnel. Of the Foundation's nine divisions covering all the physical sciences and related engineering, one of these divisions, Electrical Engineering Research, now comprises 150 employees, 95 of them professional. Under Dr. Leedy's leadership, this division has acquired prominence in electronic research and computing, and is now in the process of installing a Remington Rand *Univac 1105*. During the last decade, the Foundation has built or remodeled three large research buildings, one of them containing a research (nuclear) reactor. He has served on the Atomic Power Investigating Commission, State of Illinois. He is a member of Sigma Pi Sigma, Sigma Xi, and Tau Beta Pi. Dr. Leedy belongs to the following groups and societies: Special Advisory Committee to the Department of Commerce; Advisory Council of the Graduate Institute of Technology, University of Arkansas; Institute for American Strategy; National Research Council; Acoustical Society of America; American Society for Testing Materials; American Standards Association; National Conference on Industrial Hydraulics; National Electronics Conference; American Association for the Advancement of Science; American Institute of Physics; American Physical Society; Illinois State Academy of Science; and Institute of Radio Engineers. He is a Board member of Link-Belt Company, Elgin National Watch Company, and Nuclear-Chicago Corporation, and a trustee of the Na-

*Doctor Leedy's transfer to the grade of Fellow was approved at the Board of Directors meeting on October 16, 1959.

tional Moving and Storage Technical Foundation.

Cecil Clifton Saunders (M '42), principal electrical engineer, E. I. du Pont de Nemours & Co., Wilmington, Del., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to the electrical aspects of industrial, chemical, and nuclear projects." He was born February 3, 1898, in Stamford, Conn., and studied electrical engineering at the Drexel Institute of Technology. He was employed by the Du Pont engineering department in October 1933 as an electrical draftsman and became designer of industrial electrical systems. In 1939-42, he was assistant project engineer and had responsibility for electrical design direction of industrial projects valued at an estimated $5 million per year. During World War II, he was given the additional responsibility for the electrical design of several Chemical Warfare Department projects. In 1942-44, he became design engineer and supervised the electrical design of industrial projects valued at an estimated $10 million per year. He was appointed to a new post, assistant principal electrical engineer, in 1944, and in 1947 was named principal electrical engineer of the company and made responsible for design of all electric systems and facilities for the company's industrial plants with over-all responsibility of electrical design for Government nuclear plants. Under his direction, the Electrical Section of the Design Division contributed to the successful completion of two large nuclear plants, Hanford and Savannah River, more than two dozen major industrial factories valued in the order of $50 million each, and equivalent expansion of existing industrial facilities. Mr. Saunders has been instrumental in developing the organization to perform the vastly increased volume of high complexity work and in increasing the capabilities of this organization. He is a registered professional engineer in the State of Delaware and served as chairman of the Professional Guidance Committee of the Delaware Engineering Association. He has been a member of the AIEE Industrial and Commercial Power Systems Committee (1949-60).

David Fears Tuttle, Jr. (AM '38, M '47), professor of electrical engineering at Stanford University, Stanford, Calif., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to the theory and solution of electric networks." He was born July 5, 1914, in Briarcliff Manor, N. Y. He studied at Amherst College and then at the Massachusetts Institute of Technology (MIT) from which he received the B.S. and M.S. degrees in electrical engineering in 1938 and the Sc.D. degree in 1948. During 1938-42, he was a member of the technical staff of Bell Telephone Laboratories where he worked on the design, construction, and testing of transmission networks. This included research and development. He was on active duty in the U. S. Navy as a radar officer in 1942-45. He was in charge of maintenance of all ships' radar on the *U. S. S. Hornet* in 1945. He was an instructor of electrical engineering at MIT in the Summer of 1947. During 1948-53, he was associate professor of the electrical engineering faculty at Stanford University. Since 1953, he has been a professor at Stanford in charge of network theory and related courses. He has also taught electric circuits, analysis and synthesis, and nonlinear systems. He has supervised the research of many Ph.D. candidates and has directed and taken part in government-sponsored research and the preparation of government reports. During the academic year 1954-55, he was a visiting lecturer on electric network theory and related subjects on a Fulbright grant at the French Universities of Grenoble, Toulouse, and Nancy. He is the author of a book, published in 1958, entitled "Network Synthesis" that is definitive. Mr. Tuttle is a member of the Institute of Radio Engineers, the American Society for Engineering Education, Societe des Radioelectriciens, and Societe Francaise des Electriciens. He also belongs to Phi Beta Kappa, Tau Beta Pi, and Sigma Xi.

AIEE PERSONALITIES

O. L. Allanson, Jr. (AM '49, M '59) has become factory manager of the Ohio Brass Company plant in Mansfield, Ohio. He was appointed assistant factory manager in 1957.

Elected to the board of governors of the National Electrical Manufacturers Association at its 33rd annual convention were: **D. E. Allen** (AM '23), vice-president —sales, Anaconda Wire and Cable Company, Hastings-on-Hudson, N.Y.; **J. B. Cook** (AM '33, M '39), president, Reliable Electric Company, Franklin Park, Ill.; **C. W. Higbee** (M '37), assistant general manager, Electrical Conductor Division, Kaiser Aluminum & Chemical Corporation, New York, N. Y.; and **J. J. Mullen, Jr.** (AM '39, M '48), president, Moloney Electric Company, St. Louis, Mo.

E. F. Anderson (AM '59) has been named district engineer for the Los Angeles Division of the Clark Controller Company. He had been employed by Clark for the last 9 years as an application engineer in the Cleveland office.

G. R. Anderson, Jr. (AM '50, M '57) has been appointed general manager and director of engineering and research of Howard Industries, Inc., Racine, Wis. He became associated with Howard Industries in February 1959 as assistant to the president.

J. W. Ayers (M '43) has been named to the newly created position of director of military equipment sales in the Industrial Products Division of Automatic Electric Sales Corporation, a subsidiary of General Telephone & Electronics Corporation, at Northlake, Ill. Prior to this, Mr. Ayers was president of the Phillips Control Corporation of Joliet, Ill.

F. J. Bednarz (AM '39, M '51), Polaris development manager since 1957, has been promoted to the position of technical director in the Polaris missile system manager's office, Lockheed Missiles and Space Division.

W. P. Bell (AM '47) has been appointed sales manager of small, medium, and marine units, steam turbine department, Allis-Chalmers Manufacturing Company, Milwaukee, Wis. **H. B. Cullom** (AM '54) has been named to the Allis-Chalmers Industries Group district sales offices. An application engineer at Allis-Chalmers Boston Works since 1954, Mr. Cullom has been assigned to the company's Indianapolis district office as a sales representative. **W. L. Hopkins** (AM '59) has been named to the Allis-Chalmers General Products Division as an assistant engineer in the pump department at Allis-Chalmers Norwood Works.

J. T. L. Brown (AM '21, M '55, Member for Life) has joined Gordos Corporation, Bloomfield, N. J., as head of exploratory development of mercury-wetted relays and dry-reed switches. He recently retired after 44 years of research and development with Bell Telephone Laboratories and, previously, with Western Electric Company.

J. L. Bugler (AM '54, M '59) of Vestal, N. Y., has been appointed staff engineer in flight test projects at the Owego, N. Y., facility of the Federal Systems Division of International Business Machines Corporation (IBM). He was appointed associate engineer in October 1957. **M. B. Diegert** (AM '53) of Vestal has been appointed advisory engineer in advanced guidance systems at IBM Owego. Mr. Diegert became staff engineer in applied research and advanced development in May 1957. **R. F. Lovelett** (AM '58) of Johnson City, N. Y., has been appointed staff engineer in flight test projects at IBM Owego. Since 1958, he had been associate engineer. **C. R. Yungkurth** (AM '54) of Vestal has been named staff engineer in flight line test equipment at IBM Owego. He was first assigned at the Vestal Airborne Computer Laboratories as a draftsman in test equipment development engineering.

W. H. Burleson (M '31), manager of the power utilities department of the Ohio Brass Company since 1937, has been appointed consultant to the general sales department on extra-high-voltage transmission projects. Succeeding him as manager is **P. M. Ross** (AM '34, M '40), who has been associated with Ohio Brass for the last 25 years. His most recent position was manager of the Equipment Division of the power utilities department.

Recipients of the 1960 Fellow award of the Institute of Radio Engineers include the following: **J. F. Calvert** (AM '27, F '45), **A. N. Curtiss** (M '57), **C. E. Dean** (AM '23, F '55, Member for Life), **A. C. Dickieson** (M '41, F '59), **I. G. Easton** (AM '41, M '49), **P. G. Edwards** (AM '23,

F '59), **G. J. Fiedler** (AM '32, F '56), **G. A. Fowler** (AM '42, M '55), **R. W. Gilbert** (AM '36), **G. S. Glinski** (AM '43, M '53), **R. K. Hellmann** (AM '37, M '45), **S. W. Herwald** (AM '46, M '49), **C. L. Hogan** (M '57), **H. R. Huntley** (AM '23, F '51, Member for Life), **J. M. Manley** (M '46), **L. H. Montgomery, Jr.** (AM '51, M '54), **J. B. Moore** (M '41), **T. H. Morrin** (M '49), **Franz Ollendorff** (M '54), **H. R. Reed** (AM '28, F '47), and **E. A. Walker** (AM '34, F '47).

R. M. Casper (M '40), former general manager of the Atomic Energy Division of the Allis-Chalmers Manufacturing Company, was recently elected vice-president and general manager of this division by the firm's board of directors.

D. F. Christensen (AM '55) has been named assistant manager, Electrical Section, Product Engineering, of the Dow Corning Product Engineering Laboratories, Dow Corning Corporation, Midland, Mich.

P. T. Coffin (M '27) has been appointed general manager of a newly established Structural Division of the Aluminum Company of America. He had been manager of electrical industry sales since 1955. He has served on the AIEE Transmission and Distribution Committee (1956-60).

J. C. Creswell (AM '47), former "Tall Tom" systems integration supervisor, Hoffman Electronics Corporation, Los Angeles, Calif., has been named operations director for Hoffman's ULD-1 "Tall Tom" program.

Derio Dalasta (AM '47, M '55) has been named head of the switchgear department's new Static Relay Section of the Allis-Chalmers Manufacturing Company, Milwaukee, Wis. For the last 2 years, he had been design group head, switchgear and d-c generator controls group of C Stellarator Associates, Princeton, N. J., a department of the Allis-Chalmers Atomic Energy Division.

The appointment of new product managers for the Rome, N. Y., Cable Division of the Aluminum Company of America has been announced. Appointed were **F. R. Dallye** (AM '27, M '33), product manager for electrical conductor accessories, and **W. W. Knapp** (AM '46), product manager for overhead transmission and distribution conductors. Mr. Dallye is now located in Pittsburgh, Pa. He had been assistant manager of electrical conductor product sales since 1953. Mr. Knapp's office is in Rome. He joined the company in 1930 as a sales apprentice.

J. J. Dempsey (AM '41), vice-president of Servomechanisms, Inc., and general manager of the Mechatrol Division, has been named vice-president of the Long Island Electronic Manufacturers Council. **E. H. Swanson** (AM '45), president of Instruments for Industry, Hicksville, L. I., N. Y., former president of the council, will remain as an ex-officio member of the council's board of directors for 1 year.

P. C. Ebbers (AM '55) of Endicott, N.Y., has been appointed staff engineer in *AN/ASQ-38* Systems Integration at the Owego, N. Y., facility of the Federal Systems Division of International Business Machines Corporation (IBM). He had been associate engineer in systems integration since 1957. **R. G. Baron** (AM '59) has been appointed senior engineer and manager of navy systems engineering at IBM Owego. Mr. Baron began his association with IBM in 1955 as an associate engineer in systems research at the Owego facility.

W. H. Feldmann (M '44) has been elected a member of the Board of Directors of the Babcock Wilcox Company. He is president and a director of Worthington Corporation, and is a member of the boards of the Fidelity Union Trust Company of Newark, N. J., and Tung-Sol, Inc.

Suggested minimum design standards for both aluminum and copper connectors were developed for the National Electrical Manufacturers Association by a committee which included **Eugene Gorin** (AM '40, M '47) of the Memco Engineering and Manufacturing Company, Inc., and **M. R. Monashkin** (AM '53) of the Burndy Corporation.

L. L. Grant (AM '53) has been named marketing manager of the semiconductor department of Westinghouse Electric Corporation, Youngwood, Pa. He was formerly manager of the Machinery and Equipment Industry Section of the industrial sales department.

M. J. Gross (AM '53) has been appointed director of manufacturing, Consolidated Vacuum Corporation, Rochester, N. Y. He had been vice-president for manufacturing of Tracerlab, Inc., and general manager of its subsidiary, Keleket X-Ray Corporation.

W. W. Harger (AM '49) has joined the technical staff of the Technical Military Planning Operation of the General Electric Company's defense systems department at Santa Barbara, Calif.

R. K. Hellmann (AM '37, M '45) has been elected operating vice-president and technical director of Hazeltine Research Corporation, Plainview, L. I., N. Y. He retains his position as assistant vice-president of Hazeltine Electronics Division. He has served on the AIEE Communication Theory Committee (1955-60, chairman 1957-59), Electronic and High Frequency Instruments Committee (1956-60), and Communication Division Committee (1957-60). **F. R. Lack** (M '37, F '48) was recently elected a director and became a consultant to the research corporation. Mr. Lack is also a director of Hazeltine Corporation, parent organization of the research subsidiary. Hazeltine Corporation was founded in 1924 to develop the radio inventions of **Alan Hazeltine** (F '35, Member for Life), a professor of the Stevens Institute of Technology, who is currently a consultant to Hazeltine Research Corporation.

W. G. Hoover (AM '34, M '47), professor of electrical engineering at Stanford University, has been appointed technical director of Granger Associates. Dr. Hoover has been director of Stanford's Ryan High-Voltage Laboratory since 1957. He will retain an association with the university's academic and research activities. Dr. Hoover has served on the AIEE Electrical Insulation Committee (1959-60).

C. C. Horstman (AM '40) has been appointed manager of engineering and sales in the Westinghouse Electric Corporation's specialty transformer department at Greenville, Pa.

K. B. Karns (AM '50) has been named chief of the Navigation Aids Electronic Engineering Section in the Air Navigation Facilities Division of the Federal Aviation Agency's regional headquarters at Kansas City, Mo. He has served on the AIEE Aero Space Transportation Committee (1959-60).

P. C. Lamont (AFFIL '54) has been assigned by the Ohio Brass Company as district manager of its New York City office. He will handle a number of accounts formerly served by **D. H. Moore** (AM '15, Member for Life) who retired September 1, 1959. Mr. Lamont will also be responsible for the territory in New York State outside of New York City which he has covered since 1956.

M. M. Lanes (AM '55) has been appointed quality control manager of Hi-G, Inc., Windsor Locks, Conn. He was formerly with the Hughes System Environmental Laboratories.

J. J. McDonald (AM '49) and **L. G. Criddle** (AM '50) have been elected vice-presidents of Consolidated Systems Corporation, a subsidiary of Consolidated Electrodynamics Corporation. Mr. McDonald continues as director of engineering and Mr. Criddle as director of operations for Consolidated Systems.

E. V. Noe (AM '51), engineering department, Pacific Gas and Electric Company, has been appointed alternate for **M. W. McLaren** (AM '56) as San Francisco AIEE Section representative on the San Francisco Advisory Committee for the Engineering Societies Personnel Service, Inc. Mr. McLaren, project engineer of Bechtel Corporation, will be in Schenectady, N. Y., for his company for the present. Mr. Noe has been elected assistant treasurer of the personnel service.

W. W. Seifert (M '59) has been appointed assistant to the dean of the School of Engineering at the Massachusetts Institute of Technology (MIT). An associate professor of electrical engineering, Dr. Seifert has been active in teaching, research, and administration at MIT since joining the staff in 1944. Although he will continue to devote some of his time to teaching, his primary responsibility in his new post will be that of providing liaison between the dean's office and the faculty of the School of Engineering incidental to the Ford Foundation program.

E. M. Strong (AM '26, F '58), professor of electrical engineering, Cornell University, was elected vice-president of the

U. S. National Commission on Illumination at the annual meeting held recently at State College, Pa. **L. E. Barbrow** (AM '42, M '48) of the National Bureau of Standards was named treasurer. Elected to the executive subcommittee were: **S. G. Hibben** (AM '34, M '45), Montclair, N. J., and **R. C. Putnam** (AM '26, F '51), professor of electrical engineering, Case Institute of Technology. Mr. Strong has served on the AIEE Production and Application of Light Committee (1936-60, chairman 1941-43). Mr. Hibben was a member of the AIEE Production and Application of Light Committee (1938-50, chairman 1945-47) and General Applications Coordinating Committee (chairman 1947-48). Mr. Putnam has served on the AIEE Production and Application of Light Committee (1941-60, chairman 1951-53).

E. R. Summers (AM '38, M '44) has been appointed manager of product engineering for Norton Laboratories, Inc., Lockport, N. Y. He was formerly with the General Electric Company as a designer, mechanical engineer, product engineer, and tool engineer.

M. E. Talaat (AM '51, M '58) has joined the Nuclear Division of the Martin Company to direct all research and development efforts in the field of energy conversion.

M. G. Taylor (AM '31) has been appointed president and chief operations officer of International Power Company, Ltd., in succession to **Frederick Krug** (AM '17, F '36), who has become chairman of the board and continues as chief executive of the company. Mr. Krug is also president of the parent company, Canadian International Power Company, Ltd. Mr. Taylor had been a director of both International Power and Canadian International Power since 1956. Except for the period 1955 to date, in which he was general manager of the Nova Scotia Power Commission, his professional experience since 1927 was entirely with the International Power group of companies in Latin America. During 1938-55, he was president and general manager of the company's operating subsidiaries in Venezuela.

Named as directors of BICC-Burndy, Ltd., the British firm formed recently to manufacture and sell electrical connectors in the British Commonwealth, were: **A. G. Thomson** (AM '44, M '54) of Burndy Corporation, Norwalk, Conn., and **R. A. Crook** of BICC. Mr. Thomson had been chief engineer and works manager of Burndy Canada Ltd., a Canadian subsidiary of Burndy Corporation, and is now general manager of BICC-Burndy Ltd. Mr. Crook heads the Accessories Division of BICC.

Paul Thorne (AM '54), formerly chief electrical engineer of the National Electric Welding Machines Company, has been named chief electrical and development engineer.

F. F. Vaughan (M '26) has been named executive vice-president of Ebasco International Corporation, the service subsidiary of American & Foreign Power Company, Inc. (AFP). Formerly a vice-president of the corporation, he retains his post as a company director. For 9 months recently, he was in Argentina as the AFP representative in proceedings before the chief justice of the Argentine Supreme Court.

Seymour Weiner (AM '52) has been appointed to the newly created post of product planning manager of the Sperry Semiconductor Division, Sperry Rand Corporation, South Norwalk, Conn. He went to Sperry from recent positions as chief electronic engineer, Olivetti Corporation of America Research Center, and senior engineer at White Development Corporation.

H. J. White (M '49) has been elected a director of Research-Cottrell, Inc. Dr. White was appointed director of research and development in November 1958.

J. B. Williams (AM '43, M '52) has been appointed vice-president—engineering of Electronics Communications, Inc. He was previously director of weapons-system engineering for Philco Corporation.

R. C. Wilson (AM '47, M '58) has been appointed general manager of the General Electric Company's radio receiver department, Bridgeport, Conn. He had been manager of manufacturing and plant operations of the company's distribution assemblies department in Plainville, Conn. He replaces **W. P. Von Behren** (AM '53), who was recently named general manager of General Electric's Major Appliance Division.

John Winslow (AM '26 M '54) and **Roy Stott, Jr.** (AM '49) have been named chief engineers of the Electric Autolite Company. Mr. Winslow is in charge of directing the starting motor section, and Mr. Stott, the generator section.

E. M. Wolf (AM '52) has been appointed chief electronics engineer, Dynatran Electronics Corporation. He was formerly a project engineer with the Reeves Instrument Corporation.

F. M. Wood (AM '51) has been made vice-president in charge of research and development of the Tuboscope Company, Houston, Texas. Prior to his promotion, Mr. Wood was chief design engineer for Tuboscope.

R. M. Wopat (AM '37), president of General Telephone Laboratories, Inc., since 1956, has become president of the General Telephone Company of Illinois, with headquarters in Bloomington. **F. D. Reese** (AM '46, M '52), director of engineering for the General Telephone Service Corporation of New York, has become the new president of the General Telephone Laboratories in Northlake, Ill. General Telephone Laboratories, General Telephone Company of Illinois, and General Telephone Service Corporation are subsidiaries of General Telephone & Electronics Corporation.

M. G. Young (AM '41), chairman of the University of Delaware's department of electrical engineering, will direct an insulation research project at the University sponsored jointly by the Electronics Industries Association, the American Society for Testing Materials, and the National Electrical Manufacturers Association.

OBITUARIES

Patrick Henry Adams (AM '11, M '13, F '30, Member for Life), consulting engineer of Maplewood, N. J., died recently. He was born February 5, 1886, in Phoenix, S. C. Mr. Adams graduated from Clemson Agricultural College in 1906 with the B.S. degree in electrical and mechanical engineering, and in 1928 he received the electrical engineering degree. During 1906-09, he worked in the testing department of the General Electric Company, Schenectady, N. Y. In 1909, he entered the employ of the Public Service Electric Company as a wireman in the construction force. He was made foreman in a short time, and after about 9 months he became field engineer in charge of all electrical construction, a position he held until 1917 when he became assistant engineer, Electrical Division, engineering department. He was electrical engineer during 1922-28, and when the company was merged in 1928 with the United Gas Improvement Construction Company, Day & Zimmerman, and Dwight P. Robinson, Inc., to form United Engineers & Constructors, Inc., he continued in charge of the electrical engineering department of the Public Service Production Company Division of the new organization until the dissolution of that company in 1930. He continued as electrical engineer of the Newark Branch, United Engineers & Constructors, Inc. He served on the following AIEE Committees: Industrial and Domestic Power (1919-24); General Power Applications (1924-26); Automatic Stations (1927-30); Electrical Machinery (1935-38); and Board of Examiners (1938-60, chairman 1950-52).

Karl Andre Auty (AM '12, M '17, Member for Life), chairman of the Chicago Section, AIEE, in 1926-27, died recently at the age of 81. Prior to his retirement in 1946, Mr. Auty was senior sales representative in the electricity sales department of the Commonwealth Edison Company. He was born July 16, 1878, in Yorkshire, England. He studied at the Sorbonne University, Paris, France, and at Victoria University, Nottingham, England. In 1899, he entered the Brush Electrical Engineering Company, Ltd., Loughborough, England. During January through July 1906, he was employed by Samuel Buckley, Styrian Steel Works, Sheffield. He rejoined the Brush company in 1906 as representative and erecting engineer in Japan. In 1909, Mr. Auty was employed by the British Columbia Electric Railway Company, Ltd., Vancouver, B. C., as chief illuminating and power engineer. From 1915 until his retirement, he was employed by Commonwealth Edison Company, Chicago, Ill. He served on the AIEE Applications to Iron and Steel Production

Committee (1932-34) and Transportation Committee (1933-34).

Conway Studios

O. E. Buckley

Oliver Ellsworth Buckley (M '19, F '29, Member for Life), former president and chairman of the board of Bell Telephone Laboratories, died recently at the age of 72. A native of Sloan, Iowa, he was born August 8, 1887, received the B.S. degree from Grinnell College in 1909, and the Ph.D. degree in physics from Cornell University in 1914. After serving on the Grinnell and Cornell faculties, he joined the Western Electric Company in 1914 as a research physicist. During World War I, in 1917-18, he was a major in the U.S. Signal Corps. He returned to Western Electric and when the company's engineering department became Bell Laboratories in 1925, he was appointed assistant director of research. In 1933, he was named director of research, and in 1936, executive vice-president of the company. He served as president of the Bell Laboratories from 1940 to 1951, when he was elected chairman of the board, a post he held until his retirement in August 1952. Among his outstanding contributions was his pioneering work in submarine telephony. The transoceanic telephone cables which now connect the continental United States with Europe, Hawaii, Alaska, and Cuba owe their origin to the inspiration of Dr. Buckley's early research. He was a member of the General Advisory Committee of the Atomic Energy Commission during 1948-54, was first chairman of the Science Advisory Committee of the Office of Defense Mobilization, and was a member of the National Inventors Council. He received the Medal for Merit, the nation's highest civilian award, in recognition of his contributions during World War II. Dr. Buckley was granted 43 patents for his inventions. He was a Fellow of the American Physical Society, the American Association for the Advancement of Science, the Acoustical Society of America, and the American Academy of Arts and Sciences. He was a member of the National Academy of Sciences, the New York Academy of Sciences, the Franklin Institute, and the American Philosophical Society. He was also a member of Phi Beta Kappa, Sigma Xi, and Phi Kappa Phi. He was a member of the Engineering Foundation Board in 1938-50 and served on committees for the Case Institute of Technology, and Columbia, Harvard, Princeton, and Cornell Universities. He was a trustee of the Thomas Alva Edison Foundation. He held honorary doctor's degrees from Grinnell College, Columbia University, and the Case Institute of Technology. Dr. Buckley was awarded the Edison Medal of the AIEE in 1954. During 1946-48, he was District 3, AIEE, vice-president, and served on the following AIEE Committees: Electrophysics (1926-37, chairman 1929-31); Basic Sciences (1946-48); Research (1934-40); Charles LeGeyt Fortescue Fellowship (1939-45, chairman 1941-45); Finance (1946-47); Edison Medal (1944-49); Technical Program (1945-47); Meetings and Papers (1929-31); Executive (1946-48); Communication and Science Co-ordinating (1947-48); and Hoover Medal Board of Award (1956-61).

Lindell Lloyd Crump (M '32, F '42), a former chief engineer and vice-president of the James R. Kearney Corporation, died recently. He was born July 20, 1891, in Centralia, Mo., and received the B.S. degree in electrical engineering from the School of Engineering, University of Missouri, in 1915. In 1914-15, he was an apprentice for the Emerson Electric Company, St. Louis, Mo. During 1915-30, he was employed by the Union Electric Company of Missouri, St. Louis, on inventory field survey, distribution record work, and distribution construction standards and materials standards. In 1930-31 he was a design engineer for W. N. Matthews Corporation, St. Louis. He became design engineer for James R. Kearney Corporation in 1931 and was advanced in ensuing years to sales engineer and vice-president and chief engineer.

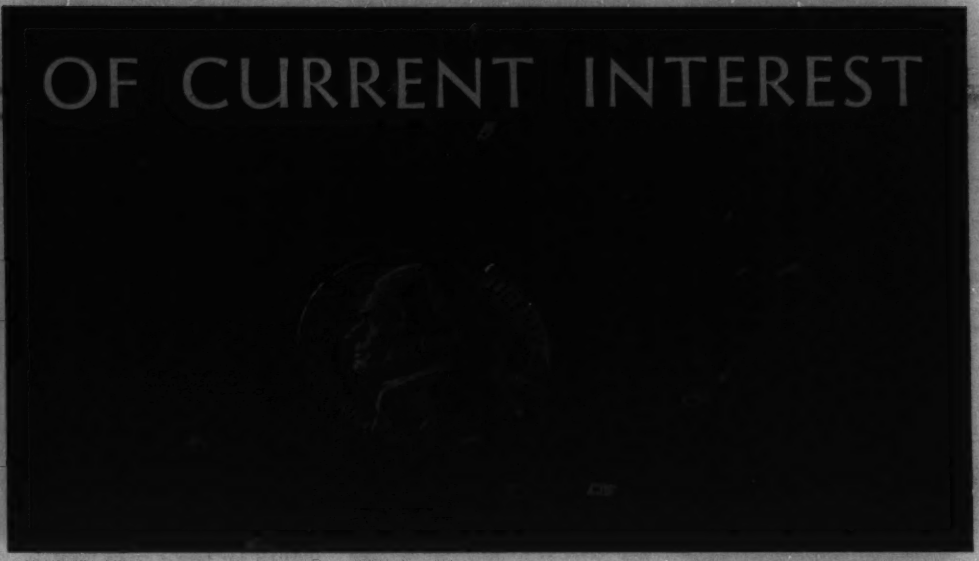
Friend Hans Kierstead (AM '15, M '29, F '49, Member for Life), former electrical engineer at the General Electric Company, Pittsfield, Mass., for more than 40 years, died recently. He was born October 3, 1885, in Warners, N. Y., and was graduated from Michigan State College in 1909 with the B.S. degree in electrical engineering. In 1910-13, he was a testing engineer for the General Electric Company, Schenectady, N. Y. He went to General Electric in Pittsfield in 1913 to take charge of reactor engineering and development. During 1913-46, he was a developmental engineer in the Power Transformer Engineering Division; in 1946-48, assistant section engineer of the division; and in 1948, he became section engineer of the division.

Linus E. Kittredge (M '40, F '47), inventory and costs engineer of the American Telephone and Telegraph Company (AT&T), died recently at the age of 61. He was born September 27, 1898, in Lockport, N. Y. He studied electrical engineering at Cornell University and joined AT&T's development and research department in 1920, where until 1934 he did design work mainly on the panel dial telephone system. During 1934-39, he was an engineer for Bell Telephone Laboratories, Inc., where he worked on the development of crossbar dial equipment. In 1939-41, he was an engineer for AT&T, and later became equipment and building engineer for AT&T in charge of staff work on telephone central office equipment and maintenance, telephone station equipment, and telephone company buildings. He became inventory and costs engineer in 1955.

John Paul Oliver (AM '52, M '54), electrochemical engineer with the National Carbon Company, Cleveland, Ohio, since 1944, died recently. He was born October 17, 1908, in Henderson, Iowa, and studied at the State University of Iowa. In 1940-44, he was a research engineer and plant superintendent for the Cardox Corporation, Chicago, Ill., after which he joined the National Carbon Company, a division of Union Carbide and Carbon Corporation. He was a member of the American Institute of Chemical Engineers, the American Chemical Society, the Electrochemical Society, and the National Association of Corrosion Engineers. He served on the AIEE Chemical Industry Committee (1956-60).

Robert Frank Ryon (AM '53), supervising design engineer, Commonwealth Edison Company, Chicago, Ill., died recently. He was born September 21, 1909, in Blue Island, Ill. He received the B.S. degree in electrical engineering in 1931 from the Armour Institute of Technology. During 1940-48, he was electrical design draftsman for the Public Service Company of Northern Illinois. In 1948-53, he was electrical design engineer for the company, and in 1953, he became supervising design engineer. He was a registered professional engineer of the State of Illinois. Mr. Ryon served on the AIEE Protective Devices Committee (1957-60).

William Henry Timbie (AM '10, M '12, F '24, Member for Life), professor emeritus of electrical engineering and industrial practice at the Massachusetts Institute of Technology (MIT), Cambridge, Mass., died recently at the age of 82. He was born August 20, 1877, in Pittsfield, Mass. A Phi Beta Kappa of Williams College in 1901, he majored in ancient and modern languages. In 1902-11, he taught physics and industrial electricity at Pratt Institute, Brooklyn, N. Y. In 1911-18, he became head of the applied science department, Wentworth Institute, Boston, Mass. During World War I, he was editor-in-chief of the War Department Committee on Education and Special Training. At the close of the war, he joined the MIT faculty. During 1919-23, he was associate professor of electrical engineering and industrial practice at MIT, and in 1923, he was advanced to professor. Professor Timbie was the author of "Elements of Electricity" and coauthor of "Principles of Electrical Engineering." He was AIEE vice-president in 1934-36 and served on the following AIEE Committees: Student Branches (1925-36, chairman 1929-33); General Power Applications (1924-30); Education (1929-33); Sections (1929-41, chairman 1936-38); Co-ordination of Institute Activities (1936-38); Publication (1936-38); Special Committee for Consideration of the Broadening of Institute Activities (1936); Special Committee on Institute Activities (1936-37); Special Committee on Joint Conference on Student Activities of Districts 8 and 9 (1937-38); and Institute Policy (1938-42).



▲*MINUTENESS OF BIAX is shown in this photo of several hundred of the new computer elements with a nickel. More than 5,000 can be held in the palm of your hand, and 310,000 will fit in a quart milk carton. BIAX, which was developed by Aeronutronic, a division of Ford Motor Company, is now in mass production.*

BIAX–
Advanced Electronic Computer Elements

A NEW CONCEPT in high-speed computation has been disclosed by Aeronutronic, a division of Ford Motor Company, Newport Beach, Calif., with introduction of BIAX, a magnetic computer element which is capable of multimegacycle performance in logical networks and memory arrays.

The BIAX element is a small rectangular bar of ferrite magnetic material measuring 50 by 50 by 85 mils. Its application now makes possible the achievement of reliable high-speed computing at a reasonable cost.

Basic Concept

The basic concept employed by BIAX is that of flux interference between orthogonal magnetic fields. This is accomplished by means of two 20-mil orthogonal holes through the element. The flux interference takes place in the magnetic material between the holes. Because of the orthogonality, no normal magnetic coupling occurs between conductors associated with the two holes in the materials.

By controlling the spacing between the holes, the flux interference techniques can be made either destructive or nondestructive. Memory applications employ the nondestructive BIAX element, whereas logical circuitry makes use of the destructive BIAX element.

In the memory element, one of the orthogonal holes acts as the storage axis while the other hole acts as the nondestructive interrogate axis. The BIAX logical element employs the same orthogonal hole technique, with the exception that the holes are placed extremely close together.

Functioning as a memory element, BIAX permits the reliable and economic realization of a very rapid random access memory unit. The elements have been interrogated over 100 billion times at a 10-mc rate with no loss in output signal, indicating true nondestructive readout and low heating.

A TYPICAL BIAX ARRAY for an electronic digital computer memory unit, this printed circuit card contains more than 300 BIAX elements. Multiples of such printed circuit cards are mounted adjacent to one another in a computer to provide large memory capability.

In addition to its ultra-high-speed memory capabilities, the new memory element permits operation under extreme environmental conditions. A BIAX memory array has been operated for 8 hours at 125 C. Extensive environmental tests indicate that arrays can be fabricated which will operate in the vicinity of the Curie temperature of the ferrite used in their manufacture.

Typical computer logical elements involve both gating elements and storage elements (flip-flops). Both types of logical elements have been successfully built and tested employing the BIAX principle.

High-speed operation up to 20 mc per second has been achieved by the use of these elements. Operational memory circuitry and logical circuitry have been fabricated and operated at 2-mc.

Using the new concept, it is now possible to achieve computational equipment where the memory access time is properly matched with the logic processing speeds.

BIAX elements are currently being produced by mass production techniques.

In production, BIAX computing equipment will be considerably cheaper than current equipment. This arises primarily because of the economies achieved in the logical devices where relatively cheap BIAX elements will replace expensive semiconductor devices. Present estimates indicate the cost saving will be

at least a factor of 10 with regard to logical devices.

Because of their favorable environmental characteristics, BIAX elements may be densely packed and, thus, permit achievement of extremely small volume, considerably smaller than is possible with semiconductor techniques. A total of 200 flip-flops and 3,000 gates—the equivalent of 15,000 to 20,000 semiconductors—can be packaged in $\frac{1}{10}$ of a cubic foot.

The application of BIAX techniques will reduce the number of solder connections in a typical computer by a factor of 10 to 100, because many of the elements may be linked by a single wire, thus avoiding the large number of solder joints necessary when semiconductor devices are used. The number of connectors will also be reduced by a factor of 10 or more.

Because of the smaller currents required to operate the BIAX memory, the total power which is required to achieve a given computational speed is materially reduced.

Reliability of the elements is high. The basic passive nature of BIAX plus its general rugged physical nature and insensitivity to temperature generally enhances the reliability by a large factor.

The BIAX concept and the associated digital computer components were invented by G. L. Wanlass, director of research for Aeronutronic's Computer Operations.

BIAX techniques are currently being applied by Aeronutronic to a number of airborne and ground-based military projects where multimegacycle data processing is required.

ENLARGED microscopic photograph (inset) of a BIAX memory element shows details of wiring in the tiny, advanced new computer component which has been developed by Aeronutronic.

Supersensitive Image Orthicon Tube Developed

A SUPERSENSITIVE television camera tube which will widen the scope of black-and-white television, and which promises to extend the general application of color television has been developed by the General Electric Company (GE).

The new image orthicon tube, type GL-7629, is physically and electrically interchangeable with standard camera tubes. It requires from 1/10 to 1/20 the light required by standard image orthicons, either black-and-white or color. It can produce pictures of usable black-and-white quality at 1 foot candle of scene illumination or less, compared to the 10 foot candles required by standard black-and-white image orthicons at the same camera lens setting.

The supersensitivity of the image orthicon tube will permit for the first time the origination of studio colorcasts under normal black-and-white lighting levels. The extremely high lighting requirements (400 foot candles and higher) of standard color image orthicons have been one of the barriers to the wide-spread application of color programming. Removal of this barrier will also make possible colorcasts from sports arenas, auditoriums, and light-equipped ballparks without the addition of special lighting, since the new tube produces quality color pictures with light levels as low as 40 foot candles. Color television, now in its 5th year, has been chained to specially equipped studios—except for outdoor events in bright sunlight—because of the economic obstacle of properly lighting night and indoor sports events and other "remotes."

J. F. McAllister, general manger of the company's power tube department, called the new tube a major advance in camera tube design and said it now gives color television most of the programming flexibility of black-and-white television.

He pointed out that color-equipped stations will be able to reduce operating costs sharply, and that many of the nation's more than 1,000 black-and-white studios could be converted to color without significant investment for additional lighting and air-conditioning equipment, or electric power. In addition, performers will no longer be subjected to the "bake-out" temperature of a set illuminated by 400 foot candles and higher.

The extreme sensitivity of the GL-7629 results mainly from a high-gain, thin-film target of magnesium oxide approximately 2 millionths of an inch thick. It is approximately 1/100 of the thickness of the targets used in conventional camera tubes. If 1,500 of the thin-film targets were stacked, they would equal the thickness of a single human hair.

THE GL-7629 image orthicon tube, developed by General Electric for color and black-and-white broadcasting and closed-circuit applications. New tube requires up to 10 times less light than standard image orthicons, offers greater resolution and depth of focus. Longer life is anticipated because of marked resistance to the problems of "stickiness" and "burn-in."

Resists "Stickiness" and "Burn-In"

For many years, scientists have endeavored to improve the targets of conventional image orthicon tubes. All such targets ultimately become "sticky"—that is, they retain the image for longer and longer periods of time. When this "stickiness" becomes noticeable by causing images of a previous scene to smear over the new scene, the tube must be retired. Stickiness has been a major reason for tube replacement.

Another limitation of conventional targets has been their susceptibility to permanent damage from "burn-in," which is caused by aiming the camera at a bright, stationary highlight for too long a time. When this happens, the target acquires a permanent after-image or "burn" which is evident in all transmitted pictures from that time on. Burn-in has been another reason for tube replacement.

Unlike conventional targets, targets in the new GL-7629 utilize a different principle of conduction. Conventional targets rely on ion conduction. Because this conduction is irreversible, the ions are ultimately exhausted and the useful life of the tube is ended.

The GE target, however, uses electron conduction. This is a reversible process, and the life of a tube is not limited by the exhaustion of charged carriers. Thus, the problems of stickiness and burn-in are virtually eliminated so that expected tube life is appreciably extended.

The GL-7629 is capable of 25 to 50% more resolution than present image orthicons. The extreme thinness of the new target inhibits sideways leakage, thus preventing loss of resolution. Moreover, its supersensitivity allows improved depth of focus, since the lens opening at normal light levels may be stopped down. While the normal network transmission bandwidth of 325-350 lines limits use of this extra resolution in daily television fare, it can be used to advantage with special-purpose camera chains for military and industrial applications.

Questioned on the alleged ability of 4½-inch targets, recently imported from Europe, to give improved performance, GE engineers asserted that the larger target is still of conventional construction; they foresee no improvement in resolution, and point out that such targets will have problems with stickiness, burn-in,

and sensitivity common to all conventional targets.

Dramatic Lighting Effects Possible

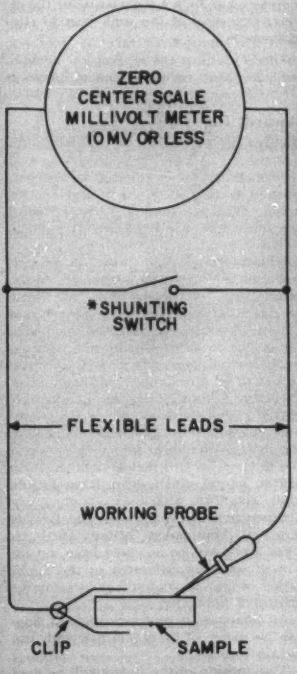
The new tube also makes dramatic lighting effects in color television easier and more economical. Because they will be working at or below present black-and-white light levels, television directors will be able to achieve the same lighting effects now used in black-and-white telecasts. While key-lighting is possible now with present color camera tubes, it requires the addition of very powerful spotlights to overcome the high overhead illumination or base-lighting which normally washes out all shadows.

Actual application of the new tube was initiated by WLW-T, Cincinnati, Ohio. After successfully testing the tube, the station originated the first colorcasts of professional basketball games over a major network on November 21 and 22. The station also has scheduled 10 Cincinnati night baseball games during 1960.

R. E. Dunville, president of the Crosley Broadcasting Corporation which operates WLW-T, has hailed the new tube as "the greatest single step (in television) since the advent of color."

Several other stations have ordered the new tube for black-and-white and color evaluation in their own television studios.

SENSITIVITY of new General Electric GL-7629 image orthicon tube is shown in "before-and-after" photos above—one at left using the standard 5820 1.0 and one at right the GL-7629. Depth of focus is indicated in photos below—one at left using the standard 5820 1.0 and one at right the GL-7629.



METAL SORTER (above) is able to identify quickly and easily metals that look alike. The simple, inexpensive device, developed at the Knolls Atomic Power Laboratory, is a standard milliammeter with two leads—one ending in a clamp and the other in a small carbon steel file. Metals are tested by attaching the clamp to them and then rubbing them with the file. This action generates a tiny current which causes the meter pointer to indicate on a special dial the kind of metal being tested. *Right:* Schematic diagram of metal sorting device. The Mechanical Equipment Development Section developed and made six models of the device for $300.

Simple Device Sorts Metals which Look Alike

A unique device which sorts different metals that look alike without costly, time-consuming, and complicated testing has been developed at the Knolls Atomic Power Laboratory (KAPL).

The simple, inexpensive tester, which can be used by anyone without special training, quickly differentiates between inconel and stainless steel, zircaloy-2 and zirconium, and zircaloy-2 and hafnium.

These nonmagnetic metals are widely used in components for naval reactors being developed by KAPL, which is operated by General Electric Company for the Atomic Energy Commission.

The device, developed by George Martin of KAPL's Mechanical Equipment Development Section, consists of a standard milliammeter with two leads—one ending in a clamp and the other in a small carbon steel file. Metals are tested by simply attaching the clamp to, and rubbing the file briskly against, the metal whose identity is in doubt.

The rubbing of the file generates a tiny current, about 5 to 10 milliamperes for inconel or stainless steel, which causes the meter pointer to indicate on a special dial the kind of metal being tested.

The device works because the polarity (electric charge) of stainless steel is different from the polarity of inconel, in respect to carbon steel. This also holds true for zircaloy-2 and zirconium, and zircaloy-2 and hafnium.

The tiny current which operates the milliammeter is a result of the thermoelectric effect. The friction between the file and test sample causes a localized

hot spot. The hot junction between the file and sample is sufficient to produce a readily measureable current.

Another application for the device, which Mr. Martin feels may prove almost as important as its metal sorting ability, is as a thermocouple tester. Thermocouples are widely used in both the nuclear and chemical industries, and can be easily hooked up incorrectly. The device, however, can be used to determine the polarity of thermocouple leads during installation to assure that they are hooked up properly, and also to check out the circuit. If no polarity is indicated, the circuit is not complete.

The new device was developed because many reactor components are made of both inconel and stainless steel, and the two metals look so much alike that it is easy to mix them up during fabrication. Stock left over from a job can easily lose its identity and be returned to the wrong stock areas.

Although the metals look alike, they have different physical properties. The inconel parts are used in certain areas because of their corrosion resistance and ability to withstand high temperatures, while stainless steel components are used in other areas where these factors are less critical.

As a further refinement, Mr. Martin has incorporated a small magnet in the handle of the file which holds it to the meter and also can be used to detect carbon steel which is magnetic.

AN ELECTRONIC SYSTEM with no moving parts that converts the heat of rocket exhaust directly into electric power to run the steering controls and electronic equipment of a rocket or guided missile has been developed by RCA and the Hunter-Bristol Division of Thiokol Chemical Corporation. System consists of special thermionic generator tube (above) in the shape of a hollow cylinder which fits like a sleeve over the flame tube attached to a solid-fuel rocket motor in a special test mount. Heat from burning fuel is converted directly to electricity by the thermionic generator, which supplies power through wire leads to measuring equipment used during tests.

Travel Grants for Congress on Microwave Tubes

The National Science Foundation will award individual grants to defray partial travel expenses for a limited number of American scientists participating in the International Congress on Microwave Tubes, Munich, West Germany, June 7-11, 1960.

An attempt will be made to have the grants approximate round-trip air-tourist fare between the scientist's home institution and the location of the meeting.

Application blanks may be obtained from the Division of Mathematical, Physical, and Engineering Sciences, National Science Foundation, Washington 25, D. C. Completed application forms must be submitted by March 31, 1960.

Rocket's Exhaust Heat Is Turned to Electric Power

An electronic generator with no moving parts, designed to convert the heat of a rocket exhaust directly to electric power to run steering controls of a rocket or guided missile, was announced recently by the Radio Corporation of America (RCA) and the Hunter-Bristol Division of Thiokol Chemical Corporation.

The new device, a developmental RCA tube of the type known as a thermionic generator, has already produced up to 270 watts of power directly from a high-temperature heat source—an output of nearly 80 watts per pound of its 3½-pound total weight. Coupled to a Thiokol solid-fuel rocket motor in a special test mount, the tube has generated useful levels of power directly from the rocket exhaust heat during preliminary evaluation tests.

According to RCA and Thiokol engineers, the results of the tests with both simulated and actual rocket heat sources have shown the feasibility of using thermionic tubes as efficient and lightweight generators to produce the electric power required in large missiles and satellite launching vehicles during the critical launching and upward flight stages. They pointed out that such devices could power the steering mechanism of the rocket as well as the guidance, telemetering, and related electronic equipment of a missile throughout the operating life of the rocket motor.

The principles of the new tube were developed at RCA's David Sarnoff Research Center, Princeton, N.J., by Dr. K. G. Hernqvist and a group of associates of the RCA Laboratories technical staff. The experimental device employing these principles in the tests was developed jointly by Dr. Hernqvist and F. H. Corregan, at RCA Laboratories, and engineers of the RCA Electron Tube Division under F. G. Block, at Lancaster, Pa.

The present experimental RCA tube has the form of a hollow cylinder. In the Thiokol test facility, it slips like a sleeve over the rocket-flame tube through which the burning fuel passes. The method of operation was described in the following way.

The device bears a family resemblance to conventional 2-element electron tubes, or diodes, in having a cathode from which electrons are "boiled" by the application of heat, and another electrode to which these electrons flow to produce an electrical output.

In the experimental tube for rocket application, the cathode is formed by the inner wall of the hollow cylinder, while the second electrode is formed by the outer wall. Between the two walls is a narrow space filled with cesium vapor.

When the cathode wall is heated by the burning rocket fuel in the flame tube, electrons are "boiled" out of the cathode material and into the space between the two walls. The cesium vapor that occupies this space becomes ionized upon contact with the hot cathode, and encourages the easy flow of electrons to the outer wall. The electric power that is generated by this process is fed to the rocket steering control mechanism or to electronic apparatus by means of cables attached to the cathode and the second electrode.

Dr. Hernqvist pointed out that the size and shape of the experimental tube were designed specifically for the Thiokol test installation in order to study the feasibility of the system. He said that the design of eventual operating types of thermionic generator tubes would vary in accordance with the various designs of the rockets in which they might be used. He added that the operating principles of the tube are identical to those demonstrated in earlier experimental thermionic generator tubes developed at RCA Laboratories for the direct conversion of the sun's heat to electric energy.

Awards for Essays on Gravity

Five awards for short essays for the purpose of stimulating thought and encouraging work on harnessing gravity are being offered by the Gravity Research Foundation.

The awards will be made on June 1, 1960, for the best 1,500-word essays on the possibilities of discovering: (a) some partial insulator, reflector, or absorber of gravity; or (b) some alloy, or other substance, the atoms of which can be agitated or rearranged by gravity to throw off heat; or (c) some other reasonable method of harnessing, controlling, or neutralizing gravity. (The essay may be less than 1,500 words; but if it is more, the judges have the right not to accept it.)

The awards will be as follows: first, $1,000; second, $300; third, $200; fourth, $150; and fifth, $100.

Essays must be received by the Gravity Research Foundation before April 15, 1960. They will be accepted from anyone who is seriously interested in the application of gravity to practical uses for the benefit of humanity.

All essays must be typewritten in English on paper 11 by 8½ inches, with two carbon copies.

The decision of the judges will be final and all essays and copies will become the property of the Foundation. The judges will give preference to essays which have

been written especially for these awards.

A title covering the area of thought expressed in the essay, and a summary paragraph of 100 words or less on a separate sheet should be provided.

Also attached should be a short biographical sketch for use by the press in case an award is earned.

Address: Gravity Research Foundation, New Boston, N. H., G. M. Rideout, President.

Transmission Line Surveyors Measure Distance by Electronics

Engineers have applied a new surveying technique for the first time to transmission line surveys and produced signficant savings in time and costs.

On a recent assignment, the engineering department of Potomac Edison Co. approved use of the new "Tellurometer" system for establishing horizontal control preparatory to mapping a band of terrain for location purposes. The electronic distance-measuring device enabled the surveyors to complete their job in a fraction of the time that traditional taping or triangulation methods would have required.

The project was to determine location for a 26-mile transmission line between Frederick, Md., and Millville, W. Va. Potomac Edison called in Air Survey Corporation, of Arlington, Va., to survey the route, put in the necessary control points, and map it. The photogrammetry firm proposed to produce the specified contour by aerial photogrammetric methods. Before the route could be flown and photographed from the air, however, it was necessary to establish a number of strategic controls along the line, points of known elevation, and distance from each other.

By traditional methods, a survey party would have taped the distance between "stations" on the ground. Considering that the line crossed three high mountains and the Potomac River, this method would have taken weeks. An alternate method called triangulation would have required the party to establish a wide network of points, to measure the angles, and then compute the distance between points geometrically.

Air Survey Corporation decided instead to try the Tellurometer system which measures distance directly by means of high-speed microwaves.

The experiment proved highly successful. The Potomac Edison project required the establishment of 10 pairs of intervisible horizontal control points through the band to be mapped. An Air Survey Corporation survey party of three men completed this assignment in 10 days. Traditional methods would have taken five men at least 30 days, the mapping firm estimated.

The measurements were accurate to one part in 15,000, the surveyors found, well in excess of that specified for the location map.

The manufacturer of the Tellurometer claimed the system is capable of measuring distances from 500 feet to 40 miles. The longest "shot" on the Potomac Edison job was 103,440.15 feet (slightly more than 19½ miles).

The portable system consists of two units, one a master unit (transmitter); the other a remote unit (receiver). The instrument records the time it takes a series of impulses to make the trip from master to remote and back. This is easily converted into miles, feet, and decimals of feet.

It took the surveyors only about 30 minutes to measure a line, including mounting the instruments at both ends.

ENGINEERS using the new electronic "Tellurometer" system of measuring distance can be miles apart and out of sight of each other. Here a surveyor is operating the small transmitter, sending microwaves to a distant receiver and taking the readings. The time it takes the radar waves to make the round trip registers on the instrument in millemicroseconds, which, in turn, are quickly translated into miles, feet, and inches. Using the Tellurometer technique, engineers can measure distances in 10 minutes that would take several days by traditional triangulation or taping. System has a maximum error of only 11 inches in 40 miles.

Highway Information Services, Washington, D. C.

AT THE RECEIVER, another operator converses freely across the miles by radiophone. The receiver is almost identical to the transmitter.

Future Meetings of Other Societies

ASHRAE, Semiannual Meeting and Exposition, Feb. 1-4, Baker Hotel, Dallas, Texas. ASHRAE, R. C. Cross, 234 Fifth Ave., New York 1, N.Y.

ISA, Instrument-Automation Conference and Exhibit, Feb. 1-4, Rice Hotel, Houston, Texas. ISA, 313 Sixth Ave., Pittsburgh, Pa.

ASTM, Committee Week, Feb. 1-5, Sherman Hotel, Chicago, Ill.

SPI, 15th Reinforced Plastics Division Conference, Feb. 2-4, Edgewater Beach Hotel, Chicago, Ill. SPI, 250 Park Ave., New York, N.Y.

IRE, 1960 Convention on Military Electronics, Feb. 3-5, Biltmore Hotel, Los Angeles, Calif., Herbert Finke, Polytechnic Research & Development Co., Inc., 202 Tillary St., Brooklyn 1, N.Y.

Pennsylvania Electric Association
Electrical Equipment Committee, Winter Meeting, Feb. 4-5, Penn Harris Hotel, Harrisburg, Pa.

Communications Committee Meeting, Feb. 11-12, Bellevue Stratford Hotel, Philadelphia, Pa.

System Planning Committee, Winter Meeting, Feb. 15-16, Pittsburgh Hilton Hotel, Pittsburgh, Pa.

AIME, Annual Meeting, Feb. 14-18, Hotel Statler and Hotel McAlpin, New York, N. Y. AIME, 29 W. 39 St., New York 18, N. Y.

First National Symposium on Nondestructive Testing of Aircraft and Missile Components, Feb. 16-18, Hilton Hotel, San Antonio, Texas. Sponsored by Southwest Section Society for Nondestructive Testing and Southwest Research Institute. W. E. Cory, SRI, 8500 Culebra Rd., San Antonio, Texas.

NSPE, Winter Meeting, Feb. 18-20, Broadview Hotel, Wichita, Kans., J. T. Kane, NSPE, 2029 K St., N.W., Washington 6, D.C.

Biophysical Society, 4th Annual Meeting, Feb. 24-26, Philadelphia, Pa. Dr. T. H. Wood, Department of Physics, University of Pennsylvania, Philadelphia 4, Pa.

Overseas

Conference on Automatic Computing and Data Processing in Australia, May 24-27, Univ. of Sydney and Univ. of New South Wales, Australia. *Deadline for paper summaries:* Feb. 1, C.H.D. Harper, Australian Natl. Committee on Computation and Automatic Control, The Institution of Engineers, Science House, 157 Gloucester St., Sydney, Australia.

3rd International Electronic Parts Show, Feb. 19-23. Parc des Expositions de la Porte de Versailles, Paris, France. National Federation of French Electronic Industries (FNIE), 23 Rue de Lübeck, Paris 16, France.

Industrial Latin American Partnership Exhibition, Apr. 1960-Oct. 1961, Parque Ibirapuera, Sao Paulo, Brazil, E. L. Neville, ILAPE Representative, 60 E. 42 St., New York 17, N. Y.

Electrical Engineers ASEE, 9th National Exhibition, Apr. 5-9, Earls Court, London, England. Electrical Engineers ASEE, Exhibition Ltd., Museum House, Museum St., London, W.C.I.

International Conference on Large Electric Systems (CIGRE), 18th Convention, June 15-25, 112 Boulevard Haussmann, Paris 8, France.

Supersonic Circuit at Tullahoma Nears Completion

◀ **BEHIND this huge "grille" are coolers through which more than 65,000 gallons per minute of cooling water will be pumped to absorb heat from the air in the supersonic wind tunnel at the Arnold Engineering Development Center. When the tunnel is completed, giant compressors built by Westinghouse will drive air through the test section at velocities from 1,000 to about 3,000 miles per hour.**

Westinghouse Photos

▲ **A PORTION of the giant 287-foot-long supersonic compressor unit built by the Sunnyvale, Calif., manufacturing division of Westinghouse. Four compressors with a total of 21 separate stages comprise this entire rotating mass which in turn is coupled to four giant motors. *Right:* Lt. Col. C. R. Flint, *(left)*, U. S. Air Force representative at the propulsion wind tunnel, discusses what is said to be the largest rotating machine ever built, with Roger Draft, project engineer for Westinghouse. This plastic scale model shows the transonic circuit of the tunnel at the lower part of the display table, and the supersonic circuit in the upper half.**

LARGEST of the 22 wind tunnels and test cells at the U.S. Air Force's Arnold Engineering Development Center in Tullahoma, Tenn., is the propulsion wind tunnel comprised of a transonic unit now in operation and a supersonic circuit nearing completion.

The propulsion wind tunnel—one of the three major laboratories at the Center—is powered by a rotating machine which is said to be the world's largest. Built by the Westinghouse Electric Corporation, the machine is over 480 feet long and develops 216,000 hp to operate the tunnels. It includes two powerful synchronous motors, each rated 83,000 hp, and two smaller "starting" motors of 25,000 hp each. The four motors, which were built at the Westinghouse East Pittsburgh, Pa., plant, are connected in tandem to drive two huge compressors—a 3-stage unit for the transonic circuit, and an 18-stage unit for the supersonic circuit.

The Center, occupying a 41,000-acre tract of land, is part of the Air Force's Air Research and Development Command which is responsible for the over-all Air Force research and development program. Operating the Center for the Air Force is ARO, Inc., a subsidiary of Sverdrup & Parcel, Inc., of St. Louis, Mo. Construction of the wind tunnels and propulsion-system test cells is under the supervision of the Tullahoma District, U.S. Army Engineers.

The transonic circuit at the Center has been conducting aerodynamic and propulsion tests for nearly 3 years, and it soon will be joined by its associated supersonic tunnel. Tests have been conducted on more than 30 of the major weapon-system projects of the U. S. Government, including the USAF Titan, Snark, GAM-72 and Bomarc missiles, nose cones for all intercontinental ballistic missiles, the Navy's Polaris, Army's Jupiter, and National Aeronautics and Space Administration's Mercury "man-in-space" project.

▲ INSIDE the huge supersonic wind tunnel now nearing completion at the Arnold Engineering Development Center, speeds of approximately 3,000 miles per hour at simulated altitudes of more than 100,000 feet will be created. The scaffolding supports workers who are installing the layer of patchwork-like insulation material which will absorb temperatures ranging as high as 650 F. Tunnel diameter at this point is about 55 feet.

▼ THESE vertical steel vanes decrease turbulence in the air flow as its direction is altered at the corners of the supersonic wind tunnel at Tullahoma, Tenn. The diameter of the tunnel is 47 feet at this point, and it ranges from 62 to 32 feet at other sections.

Westinghouse Photos

► THIS 4-motor drive system, built by Westinghouse, develops 216,000 hp. The four motors connected to two giant compressors constitute a rotating machine which is now producing transonic wind velocities and soon will be generating supersonic speeds exceeding 3,000 miles per hour in the supersonic wind tunnel at Arnold Engineering Development Center. Two of the motors, said to be the world's most powerful, are rated at 83,000 hp each, and two at 25,000 hp each. The larger units stand 21½ feet high and weigh 225 tons. The 122-ton rotors of the giant motors spin at a rate of 600 revolutions per minute.

TEST CHAMBER at U. S. Army Signal Research and Development Laboratory, Fort Monmouth, N. J., duplicates conditions found 100 miles above the earth. It is being widely used to insure that altitude-sensitive parts for missiles and satellites will function properly after launching.

Test Chamber Simulates Outer Space Conditions

An improved high-altitude test chamber that duplicates conditions met by missiles and satellites 100 miles above the earth has been put in use at the U.S. Army Signal Research and Development Laboratory at Fort Monmouth, N. J., the Department of the Army announced recently.

Atmospheric pressure in the stainless chamber can be reduced to simulate the virtually air-free environment found 100 miles above the earth. Although satellites and missiles reach much higher levels than this ionospheric zone, many conditions are the same at the higher altitudes.

The chamber, which will aid in advancing the national space program, provides a new and highly accurate means to insure before launching that equipment and components have been engineered to retain their operating stability.

The new test chamber, a stainless steel cylinder 8 feet long and 5½ feet in diameter, doubles the simulated altitude of the 200,000-foot stratospheric chamber previously used. It can withstand a surface pressure of 15 pounds per square inch when air is pumped from the inside.

A highly efficient refrigeration system and an array of infrared heat lamps make it possible to vary test chamber temperature from —90 to +300 F.

Engineers of the Laboratory's Equipment Analysis Division established the performance characteristic of the space test chamber. It was built on contract by the NRC Equipment Corporation, a subsidiary of the National Research Corporation, Newton, Mass.

Tap-Proof Cable Insures Private Conversations

Companies using television, telephone, or wire photos in internal communications networks can be sure that their lines are free of eavesdroppers by means of a tap-proof tamper-proof cable recently made available to private industry.

The patented cable made by Mosler Research Products, Inc., an affiliate of the Mosler Safe Company, provides absolute protection against tapping by direct contact or induction. In the event that an attempt to connect into the cable is made, an alarm is automatically sounded without the intruder being aware of it.

The communications circuits are covered by successive layers of foil sheathed in plastic and connected to a highly sensitive relay apparatus which responds to changes in electric current as low as two one millionths of an ampere.

Attempts to tap the wire activate a relay causing an alarm to sound at a control point. The insertion of even a pin into the cable will trip the sensitive alarm.

Additional protection against inductive tapping is provided by a noise generator which transmits a signal many times greater than the amplitude of a conversation carried in the cable. The noise covers the complete audio frequency range and cannot be eliminated by filters or other means, thus making an induction tap impossible.

The cable permits point-to-point security, for the first time, on lines handling classified information. This is regarded as vital for companies in defense work and restricted projects, as well as those seeking to protect themselves from "industrial spies."

3-Dimensional Study of X Rays Finds Faulty Parts of Missiles

A simple method that allows 3-dimensional study of X-ray films to find faulty parts of missiles and space vehicles before launch has been perfected by reliability engineers of Convair (Astronautics) Division of General Dynamics Corporation, producer of the Atlas intercontinental ballistic missile.

Based on the use of stereovision, this method requires that two X-ray films be taken of each component to be studied. These films, termed the "left eye" and "right eye" negatives, are taken at slightly different angles, using standard X-ray equipment. The films are then studied in two modified X-ray film viewers and a mirror system in which two mirrors are set at a 45-degree angle to one another, forming a V-shape.

In use, the observer places his head against the point of the "V" so that each eye looks into a different mirror. He then adjusts the mirror so that the images of the negatives are superimposed in the mirror reflectors.

Due to the slight difference in the angles at which the two X-rays were taken, each of the observer's eyes sees a slightly different image. This is analogous to human vision, wherein each eye sees an object from a slightly different angle, this being one of nature's aids to depth perception. Here, the offset images likewise yield depth perception.

J. L. Minos, Convair-Astronautics engineer, said:

"The use of stereovision allows us to detect minor flaws in internal components which might not be discovered using conventional X-ray examination. The method has been used successfully in checking Atlas missile components as part of the company's reliability program."

Knowledge of the exact locations of such things as fine wires in encapsulated parts is often essential to failure diagnoses, Mr. Minos said. He added that in many instances this can only be achieved by viewing failed parts stereoscopically.

The prior use of stereoradiography allows a failed part to be opened for more detailed examination without inadvertent damage to the part or destruction of existing evidence of failure. Parts ranging in size from that of a thumbtack to 289 square inches in cross-sectional area can be studied by this method, it was stated.

"Wirefax" Service Offered for Use of General Public

Transcontinental Public Facsimile ("Wirefax") service for the use of the general public and other users has been inaugurated by Western Union. It is now possible for customers in New York, N.Y.; Washington, D.C.; Chicago, Ill.; Los Angeles, Calif.; and San Francisco, Calif., to give material such as full page communications, letter-size documents, drawings and other recorded data to the telegraph company for same-day transmission and delivery in exact facsimile of the material offered.

Wirefax circuits which will carry a single page of material coast-to-coast in 6 minutes have been established between the initial five cities. Original line drawings, advertising layouts, sketches, charts, and legal or financial documents or other graphic matter, excluding photographs, can be transmitted as a single page or in sections up to 7½ by 9½ inches in size. In addition, lengthy messages, either typed or hand-written, up to 600 words on a single page, can also be transmitted at relatively low cost.

The material to be transmitted must be typed, written, or drawn on a sheet of white paper of standard 8½ by 11 inches letter size. This is placed on the Wirefax facsimile transmitter drum, which, at the push of a button, begins revolving at 180 rpm. As the drum revolves, an "electric eye" scans the material at 1.8 vertical inches a minute. The copy is received immediately at the destination city, where the receiving machine ejects an exact facsimile of the original.

The local Western Union offices in New York City, at 60 Hudson St., 40 Broad St., and Grand Central Terminal, have been equipped to provide the new service be-

tween the hours of 9 a.m. and 6 p.m., Monday through Friday. Initially, the material to be transmitted will be delivered to the designated Western Union office by the sender. The telegraph company will deliver received material to the addresses at destination cities as a part of the service.

Charges for transmission of a minimum message covering 7½ by 4 inches range from $2 to $4 depending on the destination city. Additional vertical inches cost between 35 cents and 65 cents. For example, 7½ by 4 inches between New York and Los Angeles cost $4.

Western Union General Manager J. D. Johnson stated that the offering of the new service is designed to determine the extent of present demands for this type of facsimile service. He said that American business firms now use more than 37,000 Western Union Desk-Fax facsimile machines for local pick-up and delivery of 40 million telegrams annually between their offices and central telegraph offices.

Electronic Machine for Measuring Production Standards

A machine that can inspect production line output quicker than the human eye has been developed by American Machine & Foundry Company, (AMF).

The first portable electronic device to measure production line standards and quality control, the new AMF Standard Deviation Meter will have applications in many industries using the standard deviation method of measurement.

The instrument electronically counts, weights, computes, and records the individual standard deviation of production line items. It compares each product with its average standards and then computes the deviation from the standards. The complete measuring procedure is done in approximately one-hundredth the time required by manual methods for the same operation.

First application of the AMF machine will be in the cigarette manufacturing industry where it will monitor cigarette production and maintain quality and weight standards. The machine will check the standards of 2,000 finished cigarettes in less than 2 minutes compared to the 3 or 4 hours required to inspect that quantity by hand.

It is anticipated that the new machine will have application in many mass-production industries where close quality control is required, such as automotive parts, screw machine, canning, and food processing.

The output of the machine can be presented on a meter scale, recorded on a chart, or printed in digital form on paper tape. The unit operates from standard electrical service and can be installed quickly by plant personnel at any location along a production line.

STANDARD DEVIATION METER developed by American Machine & Foundry Company in use in a cigarette manufacturing plant. This is the first portable electronic device to measure production line standards and quality control by the standard deviation method of measurement.

New Prefixes for Units

The National Bureau of Standards (NBS), as announced in the NBS Technical bulletin, October 1959, has decided to follow the recommendations of the International Committee on Weights and Measures to use new prefixes for denoting multiples and submultiples of units. The Committee adopted the prefixes at its meeting in Paris, France, in the Fall of 1958. In addition to the 8 numerical prefixes in common use, which are given in the accompanying table, the Committee expanded the list by adding the 4 prefixes marked with an asterisk. Thus, for example, 10^{-12} farad is called 1 picofarad, and is abbreviated 1 pf.

Multiples and Submultiples	Prefixes	Symbols
$1\,000\,000\,000\,000 = 10^{12}$	tera*	T
$1\,000\,000\,000 = 10^{9}$	giga*	G
$1\,000\,000 = 10^{6}$	mega	M
$1\,000 = 10^{3}$	kilo	k
$100 = 10^{2}$	hecto	h
$10 = 10$	deka	dk
$0.1 = 10^{-1}$	deci	d
$0.01 = 10^{-2}$	centi	c
$0.001 = 10^{-3}$	milli	m
$0.000\,001 = 10^{-6}$	micro	u
$0.000\,000\,001 = 10^{-9}$	nano*	n
$0.000\,000\,000\,001 = 10^{-12}$	pico*	p

H. L. HOFFMAN *(left)* president of Hoffman Electronics Corporation, draws sample of first fresh water converted from salt water by solar power during the dedication of the new Hoffman Semiconductor Center, El Monte, Calif., with Dr. Morton Prince, vice-president-research, Hoffman Semiconductor Division, lending a hand. The device, part of a solar exhibit demonstrating the feasibility of new solar energy applications, derives its power from "Big Bertha," said to be the world's largest solar energy converter.

Solar Energy Used To Convert Salt Water

Successful conversion of salt water into fresh water through a device powered entirely by solar energy was reported recently by Hoffman Electronics Corporation.

The device, capable of freshening 3 gallons of water per hour, is powered by "Big Bertha," a solar power converter.

The salt water converter and a centrifugal pump, capable of lifting a 1-inch column of water 10 feet, are part of a permanent display at the Hoffman Semiconductor Center in El Monte, Calif., designed "to stimulate ideas for greater utilization of solar energy to do Man's work," H. L. Hoffman, president, explained.

He noted that many of the world's highly populated yet relativey dry areas, incuding Southern California, are adjacent to plentiful supplies of salt water.

"Converting this salt water into fresh water, using only the sun as an energy source, offers one of the most exciting challenges in science," he said. "We know that at high noon the sun places 1,000 watts of energy per square yard on the earth's surface; the problem is to convert it economically into a usable form of energy.

"While the cost per gallon of converting sea water by this method remains prohibitive at this time, significant progress has been made. The cost of a solar energy converter, for example, is approximately one-tenth today of what it was 4 years ago."

Equally challenging, Mr. Hoffman said,

is the idea of harnessing free power from the sun to operate water wells and irrigation systems in desert areas remote from conventional power sources.

The salt water converter operates on the principle of ionization. As the brine flows through a series of electrodes, an electric current causes the sodium and chlorine ions forming salt to separate. These ions form in deposits on the electrodes and can later be removed.

Big Bertha has been installed permanently on the Semiconductor Center's roof to provide power for the salt water converter, pumping station, and other experimental solar energy application devices.

The giant generator converts light into electricity by means of 7,800 silicon solar cells similar to those used to power the instruments in United States satellites. These cells are attached to a 4- by 8-foot panel. An automatic tracking device keeps the panel faced toward the sun for maximum efficiency.

Ten individual panels in the unit can be connected in various combinations of series and parallel arrays, through a control device, to provide voltage outputs of from 6 to 60, in increments of 6, and current flows ranging from ½ to 5 amperes in ½-ampere increments.

British Instrument Magnifies Light 50,000 Times

An "Image Intensifier," described as "an exceptional breakthrough" in the field of optical imagery, has been developed in Britain.

A research worker, a student, and a small group of assistants working in the department of instrument technology of the Imperial College of Science in London were responsible for the device which intensifies light 50,000 times and illuminates optical images invisible to the naked eye to the point where they can be seen and photographed.

The intensifier is expected to have particular application in astronomy, nuclear physics, and also in hospital X-ray examinations.

The ability to photograph sky bodies by almost instantaneous "snapshot" exposures through the intensifier would largely overcome the problem of local disturbances in the earth's atmosphere encountered with lengthy telescope exposure, and open up the prospect of examining the spectra of some of the faintest stars.

In nuclear physics, the instrument is to be tried in conjunction with a new method of observing the geometrical shape of the track of nuclear particles. In hospitals, after further development, it may greatly reduce the exposure needed in X-ray examinations, thereby lessening the hazards of radiation.

Principal workers on the invention were Dr. W. L. Wilcock and research student D. L. Emerson. Head of the 4-year-old department, Prof. J. D. McGee, described the work as "an exceptional breakthrough of the kind that may occur only two or three times in a scientist's lifetime."

The instrument itself is original not in concept but in method of construction. Designed to multiply the brightness of a faint image, it effectively combines multiplication of light with adequate definition. It can turn the smallest pulse of light energy into a flash that is visible and the image into a pattern that is discernible.

The intensifier comprises a glass vacuum tube about 18 inches long by 2 inches in diameter. It operates by focussing the original faint picture onto a light-sensitive cathode inside it. The cathode emits electrons which are passed, successively, through five dynodes situated along the length of the tube. Conducting coils surrounding the tube produce a magnetic field that acts as a guide to the electrons within. The cathode is made of a thin layer of an antimony and cesium compound (obtained by evaporating the cesium in a vacuum onto a thin film of the antimony), which acts as a semiconductor. From every 20 or so photons (or atoms of light) which fall on this material, 1 electron is produced.

(The dynodes are films of complicated layer-structure, each between 4 and 5 millionths of a centimeter thick. A thin but transparent layer of aluminum is encased between a layer of aluminum oxide and one of potassium chloride, the whole providing electrical contact with the structure. The layer of aluminum is made by evaporating the metal in a vacuum. The aluminum oxide is formed on the surface of a piece of aluminum, then obtained as a film by etching away the aluminum with acid. After the tube is assembled, the whole is furnace-baked to stabilize the photocathode—but without harming the potassium chloride and other films.)

Each electron from the photocathode hits each successive dynode at speed, being accelerated along its course by more than 1,000 volts. At every dynode, each will produce some five new electrons, and these in turn hit the next dynode—to be again multiplied. At the end, at least 3,000 electrons are produced for each one originally leaving the cathode. A final accelerating electric field throws them against a fluorescent screen, and a visible flash of light is produced.

The geometrical optics of the tube are good enough for details in the pattern on the cathode about 1/15 millimeter in diameter to be reproduced clearly on the screen.

The present area of the dynodes is small—just smaller than a dime. It is planned to enlarge them in future instruments.

Even with these small pictures, detail is on a par with a 250-line scanning television system. With bigger dynodes, performance approximating a 600- to 700-line scanner could probably be achieved.

New Headquarters for ASM

AERIAL VIEW (below) shows entire American Society for Metals (ASM) headquarters building and environment at Metals Park, Novelty, Ohio, 23 miles east of Cleveland. Directly under the geodesic dome is a 100-foot diameter mineral garden cut 7 feet into the earth. On completion, the garden will display some 350 specimens of native minerals, all bearing descriptive labels. *Left:* Close-up of new building shows novel stainless steel sunscreen that will control the interior lighting of the building during every daylight hour throughout the year except at the exact moment when the sun is at its lowest point in the sky.

NEW BOOKS

The following new books are among those recently received at the Engineering Societies Library. Unless otherwise specified, books listed have been presented by the publishers. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books in question.

ANALOG METHODS; COMPUTATION AND SIMULATION. By W. J. Karplus and W. W. Soroka. Second edition. McGraw-Hill Book Company, 330 W. 42nd St. New York 36, N. Y. 1959. 483 pages, 6¼ by 9½ inches, bound. $12.50. This is a survey of analog methods and techniques in use today. Beginning with the methods by which mathematical operations required for indirect computations are accomplished, it continues with the analog solution of differential equations, simultaneous linear algebraic equations, and nonlinear algebraic equations. The concluding section is devoted to direct simulation. In this edition, the emphasis has been shifted from mechanical to electric and electronic equipment. The original chapter on electrical, electromechanical, and electronic computing elements has been expanded into three chapters, and the length of the discussion of electronic differential analyzers has been more than tripled.

ANALYSIS OF ELECTRIC CIRCUITS. By Egon Brenner and Mansour Javid. McGraw-Hill Book Company, 330 W. 42nd St., New York 36, N. Y., 1959. 703 pages, 6¼ by 9¼ inches, bound. $9.50. An introduction to linear circuit analysis which provides an integrated treatment of circuit response by the early introduction and application of the concepts of complex frequency and network functions and their poles and zeros is presented. The topics covered include waveforms, response of single elements, Kirchhoff's laws and network equations, circuits containing only one type of element, complex numbers and their application to sinusoidal time functions, source-free *R-L-C* circuit, response of circuits with sources, network functions, circuits in the sinusoidal steady-state, 3-phase circuits, circuits with magnetic coupling, and harmonic analysis and Fourier series.

ATOMIC ENERGY IN THE SOVIET UNION. By Arnold Kramish. Stanford University Press, Stanford, Calif., 1959. 232 pages, 5¾ by 9¼ inches, bound. $4.75. Although the United States and Great Britain have both published complete reports on the development of their atomic energy programs, Soviet Russia has never done so. This book is an attempt to fill this gap by providing an overall review of the history, present scope, and future possibilities of Soviet nuclear research and development. The information which forms the basis for this book was obtained by systematically scanning many thousands of Soviet newspapers and technical journals, and represents as complete a picture of the situation as is now currently available.

AUTOMATIC TEACHING. Edited by Eugene Galanter. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 1959. 198 pages, 6 by 9½ inches, bound. $3.25. This is one of the first books to record and evaluate the methods associated with the newly developed field of machine teaching. It is based on a collection of 16 papers given at a symposium held at the University of Pennsylvania under the auspices of the U. S. Air Force. The various aspects of machine teaching dealt with include programming, analysis, machine design, experimental results, and criticism.

BELASTUNGSKURVEN UND DAUERLINIEN IN DER ELEKTRISCHEN ENERGIEWIRTSCHAFT. (ENZYKLOPADIE DER ENERGIEWIRTSCHAFT, Volume 2). By Max Wolf and Hellmuth Junge. Springer-Verlag, Berlin, West Germany, 1959. 563 pages, 6¼ by 10 inches, bound, DM 97.50. This second volume deals with load and duration curves in electric power economy. It includes chapters on the concept of a load curve and its graphic representation; the actual load curves of the effective load; standardized curves of the effective load; relationships between actual, reactive, and apparent efficiency and cost; actual curves of reactive and apparent efficiency; and methods for the determination of a load curve as well as of power and consumption curves, etc.

THE CATHODE-RAY TUBE AND ITS APPLICATIONS. By G. Parr and O. H. Davie. Third edition. Reinhold Publishing Corporation, 430 Park Ave., New York, N. Y., 1959. 433 pages, 5¾ by 8¼ inches, bound. $9.50. The use of the cathode ray tube in oscillography is stressed in this volume which provides a guide to the operation and use of the tube as a versatile measuring instrument. Among the topics considered are power supplies, amplifiers, time and frequency bases, photographic recording, and transducers, as well as mechanical, electrical, and nuclear applications. While the sections dealing with applications and associated circuits have been considerably expanded in this edition, only a superficial coverage is given to the theory and design of the electron gun.

DIGITAL COMPUTER PRIMER. By E. M. McCormick. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N. Y. 1959. 214 pages, 6¼ by 9¼ inches, bound. $7.50. The basic principles of digital computers are presented in nonmathematical terms. Following a review of basic terminology and sequence of operations, a detailed description is given of coding, number systems, logic of computers, and the control, arithmetic, storage, and input-output units. Instructions, programming, and methods of checking accuracy are also discussed. An appendix provides material on the value of representing logical operations by means of Boolean algebra and the basic manipulations possible.

EINFUHRUNG IN DIE THEORETISCHE ELEKTROTECHNIK. By Karl Küpfmüller. Sixth edition. Springer-Verlag, Berlin, West Germany, 1959. 212 pages, 6¾ by 10 inches, bound, RM 31.50. Various subjects have been expanded in this revised edition, e.g. the theory of networks; the theory of semiconductors and their application; the theory of rectifiers and amplifiers, including magnetic amplifiers; and line theory, considering variable line constants. Theoretical fundamentals of new components, such as the magnetic core memory, Hall generators and superconductors, have also been added. There is a bibliography of mainly German references.

ELECTRON PHYSICS. By O. Klemperer. Academic Press Inc., 111 Fifth Ave., New York 3, N. Y., 1959. 248 pages, 5½ by 8¾ inches, bound. $7. The physics of the free electron is presented in two parts. The first contains a brief survey of methods for the production of electron rays as well as a detailed discussion of the main problems of electron motion, of electron optics, of the flow of electrons in dense space charges, and of the statistical fluctuations in low intensity beams. The second part deals with the fundamental properties of the free electron, namely its charge, mass, wave-length, spin, and magnetic moment. It also includes a description of the study of the free electron by quantitative methods.

ENCYCLOPEDIC DICTIONARY OF ELECTRONICS AND NUCLEAR ENGINEERING. By R. I. Sarbacher. Prentice-Hall, Inc., Englewood Cliffs, N. J., 1959. 1,417 pages, 7½ by 10 inches, bound. $35. This extensive work defines terms and provides descriptions and diagrams of equipment, components, and systems employed in electronics and nuclear engineering. Additional definitions are provided for terms in such closely related fields as electricity, physics, chemistry, and acoustics, particularly where they have a bearing on electronic and nuclear applications. Extensive cross-referencing is provided so that related entries may be studied and compared.

FERRITES. By J. Smit and H. P. J. Wijn. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 1959. 369 pages, 6 by 9½ inches, bound. $10. Characteristics of ferrites that are of importance for application purposes are presented, and where possible explained in terms of intrinsic properties. These properties are in turn treated in relation to the chemical composition and crystal structures of the materials. Particular attention is paid to the phenomena occuring in ferromagnetic materials during various processes of magnetization. The term ferrite, as used in this text, refers to all magnetic oxides containing iron as the major metallic component.

HANDBOOK OF AUTOMATION, COMPUTATION, AND CONTROL. Volume 2. Edited by E. M. Grabbe and others. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 1959. Various pagings, 6 by 9¼ inches, bound. $17.50. The second of three volumes, this volume provides a comprehensive coverage of the design and use of analog and digital computers and data processors. Some of the features of this handbook are chapters which deal with computer terminology, magnetic core and transistor circuits, advanced programming, and unusual computer systems involving operational digital techniques, combined analog-digital computer systems, and turing-type computers.

HANDBOOK OF ELECTRONIC CONTROL CIRCUITS. By John Markus. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N. Y., 1959. 167 pages 9 by 11½ inches, bound. $8.50. The more than 250 electronic circuits included cover such areas as alarm, audio control, computer control, machine control, magnetic amplifiers, nucleonics, process control, servomechanisms, switching, and telemetering control. In addition to component values, a description is given of the general nature of the circuit and how it works, practical data on critical components, and suggested applications.

INTRODUCTION TO NUCLEAR POWER COSTS. By Arnold Rochman. Simmons-Boardman Publishing Corporation, 30 Church St., New York 7, N. Y., 1959. 50 pages, 5½ by 8½ inches, paper. $5. This book analyzes some of the factors which make up the total cost of nuclear power, and shows how variations in their value may affect the over-all cost structure. The costs of the various factors related to nuclear fuels are first analyzed, and then the factors related to the capital structure, plant, and equipment.

MAGNETIC PROPERTIES OF METALS AND ALLOYS. By R. M. Bozorth, and others. American Society for Metals, Metals Park, Novelty, Ohio, 1959. 349 pages, 6 by 9¼ inches, bound. $8. In this collection of papers, the authors discuss magnetic domain structures, nuclear magnetic resonance in magnetic crystals, magnetic properties of thin films, magnetic properties of fine particles, time effects in magnetization, magnetostriction, magnetomechanical damping, spin clusters in iron near the Curie temperature, and magnetic annealing.

MATHEMATICS FOR COMMUNICATION ENGINEERS. By S. J. Cotton. The Macmillan Company, 60 Fifth Ave., New York 11, N. Y., 1959. 245 pages, 6½ by 10 inches, bound. $7.50. Written for the practicing engineer and the advanced student, this text covers the various phases of mathematics useful in electronics. It includes such topics as Laplace transformation and probability, complex functions, differentiation, integration, Taylor's series, and trigonometrical functions. Numerous examples help to relate the theoretical and practical aspects of the subject.

A NEW METHOD IN THE THEORY OF SUPERCONDUCTIVITY. By N. N. Bogoliubov, and others. Consultants Bureau, Inc., 227 W. 17th St., New York 11, N. Y., 1959. 121 pages, 6 by 9½ inches, bound. $5.75. In this translation from the Russian, a microscopic theory of superconductivity is developed on the basis of a physical and mathematical analogy with superfluidity. Calculations are given for the energy of the superconducting ground state using Fröhlich's Hamiltonian, as well as for the one-fermion and collective elementary excited states. A detailed analysis of the role of the Coulomb interaction between the electrons in the theory of superconductivity is then presented. It is then demonstrated how a system of fermions is treated with a fourth-order interaction Hamiltonian

and a criterion for its superconductivity is established.

OPERATIONS RESEARCH; AN ANNOTATED BIBLIOGRAPHY. By J. H. Batchelor. Second edition. Saint Louis University Press, Saint Louis, Mo., 1959. 865 pages, 5¼ by 8¼ inches, bound. $10. The rapidly growing literature of operations research is extensively covered in this bibliography which includes 4,195 abstracts of books and articles published up to the end of 1957. The abstracts are arranged by author, with a subject and title index to facilitate access to the items included. The material included has been confined to operations research as such, and does not include related specialties such as linear programming, cybernetics, etc.

RADIO TUBE VADE-MECUM. Edited by J. A. Gijsen. Fourteenth edition. P. H. Brans, Ltd., Antwerp, Belgium, 1958. 464 pages 8 by 11½ inches, paper. No price given. This new edition of a standard reference work lists radio tubes manufactured in all parts of the world. Normal operating data and the function of each tube listed is given. In the case of rectifiers, the data are limited to the maximum operating conditions with capacitor input.

SEMICONDUCTORS. By R. A. Smith. Cambridge University Press, 32 E. 57th St., New York 22, N. Y. 1959. 494 pages, 6¼ by 9¼ inches, bound. $12.50. A comprehensive account of the physics of semiconductors is given along with a brief review of their applications. The author discusses energy levels in crystalline solids; impurities and imperfections in crystals; carrier concentrations in thermal equilibrium; electron transport phenomena; thermal, optical, and high-frequency effects in semiconductors; diffusion of electrons and positive holes; measurement of semiconductor properties; and the properties of the various types of semiconductors known. The treatment is based on the "effective mass" concept, and only a brief and elementary account is given on the quantum theory underlying the motion of electrons through a crystal.

TRANSFORMERS FOR THE ELECTRIC POWER INDUSTRY. By R. L. Bean and others. McGraw-Hill Book Company, 330 W. 42nd St., New York 36, N. Y., 1959. 409 pages, 6¼ by 9¼ inches, bound. $12.50. All aspects of transformers are covered beginning with the fundamentals and continuing with the details of construction, connections, testing, maintenance, field operation, and economics of design. Auxiliary and protective equipment are also discussed, along with recent developments in methods of temperature calculation, testing techniques, estimation of eddy and stray losses, gauging of transformer's life span, and insulation materials and methods. A considerable amount of the material included is based on researches reported to the AIEE.

TECHNICAL LITERATURE

The following recently issued technical literature may be of interest to readers of *Electrical Engineering*. All inquiries should be addressed to the issuers.

MAGNETISM AND ELECTROMAGNETISM. This book is volume No. 20 in the Electronic Technology Series dealing with those aspects of magnetism and electromagnetism which underlie the operation of communication and industrial electronic devices. The intent of this book, the first in a 2-volume treatment of the subject, is to give attention to the major theoretical considerations of magnetism, magnetic circuits, and electromagnetism at the intermediate level. The mathematical techniques used are simple but extensive enough to develop in the reader the mastery of typical computations. Review problems are found at the end of each chapter. The book is available from John F. Rider Publisher, Inc., 116 W. 14th St., New York 11, N.Y., at $1.80 per copy.

Library Services

ENGINEERING Societies Library books, except bibliographies, handbooks, and other reference publications, may be borrowed by mail by AIEE members for a small handling charge. The Library also prepares bibliographies, maintains search and translation services, and can supply a photoprint or a microfilm copy of any item in its collection. Address inquiries to R. H. Phelps, Director, Engineering Societies Library, 29 W 39 St., New York 18, N. Y.

INSULATION FOR SMALL TRANSFORMERS. Providing valuable guidance and data for designers of all forms of electrical insulation, this handbook is particularly useful for assessing the applications of new materials, and the insulation requirements for unusual service conditions. Factors which affect the electric strength and the life of insulation in service are considered. Graphs are provided showing the variation of discharge inception stress with the thickness and permittivity of insulation, both for surface discharges and for internal discharges in cavities of varying thickness. Mechanism of breakdown by discharges in "solid," and in oil-impregnated paper insulation are described and graphs and tables illustrate the relative resistance to breakdown by discharges of surface tracking in 20 different sheet and moulded insulating materials. This pocket-size book may be obtained from the Electrical Research Laboratories, Leatherhead, England. The price is 37s.6d. plus postage.

THE CHEMICAL INDUSTRY FACTS BOOK. This 1960-61 edition reflects the latest information on what the chemical industry is, what it does, and touches on the key role that its products play in individual daily life as well as in every industrial segment of the United States. It is divided into four sections: The Chemical Industry in the United States; How the Chemical Industry Operates; Chemicals in Everyday Life; Chemicals in the Service of Man. The book is available at $1.25 from Manufacturing Chemists' Association, Inc., 1825 Connecticut Ave., N. W. Washington 9, D.C.

OTS PUBLICATIONS. The office of Technical Services (OTS) has made the following reports available to the public: *Report of the Sodium, Heavy-Water Reactor Task Force*, TID-8515, published by the Atomic Energy Commission (AEC), 36 pages, 50¢, which evaluates the sodium, heavy-water reactor concept on the basis of its technical feasibility and also its potential for the economical production of electric power; *Report of the Fluid Fuel Reactors Task Force*, TID-8501, AEC, $1.75; *Task Force Evaluation Report—Small-Size Nuclear Power Plant Program*, TID-8508, AEC, $1.75; *A System for Monitoring the Electrocardiogram during Body Movement*, PB 151906, U.S. Air Force, April 1959, 50 pages, $1.25; *Short Duration Harmonic Analysis of EEG Data*, PB 151868, U.S. Air Force, February 1959, 16 pages, 50¢, which reports that discrimination between human "states of consciousness" by analysis of short pieces of electroencephalographic data is possible; *Materiel Information Flow Research:* Part 1, PB 151950, U.S. Air Force, March 1959, 177 pages, $4, which discloses a system built around the Materiel Information Flow Device (MIFD), a medium-speed electronic data processor which serves as a central record-keeping device. All six reports may be ordered from OTS, U.S. Department of Commerce, Washington 25, D.C.

AWS PUBLICATIONS. The American Welding Society (AWS) has announced three publications. *Titanium Welding* is a 24-page report which gives the complete story on titanium welding. The contents include: process, power supply, electrodes and filter metal, titanium grades, joint design and preparation, cleaning, gas shielding, welding techniques, heat treatment, weld quality tests, price $1.50 per copy. *Filler Metal Comparison Charts* is a 48-page booklet containing a complete set of welding rod and electrode charts. The brand names of 78 companies are listed. 15 AWS-ASTM (American Society For Testing Materials) specifications are involved and brands as well as manufacturers' names are contained in two indexes, price $2.50. *Welding Nuclear Power Piping* is a 20-page report, compiled by nuclear power experts. The material includes: welding procedures, detailed sketches of operations, joint design, (angles and dimensions), quality control, qualifications of procedures, qualification of welders, and inspection methods, price $1.50. All three publications may be obtained from the American Welding Society, Dept. T., 33 W. 39th St., New York 13, N.Y.

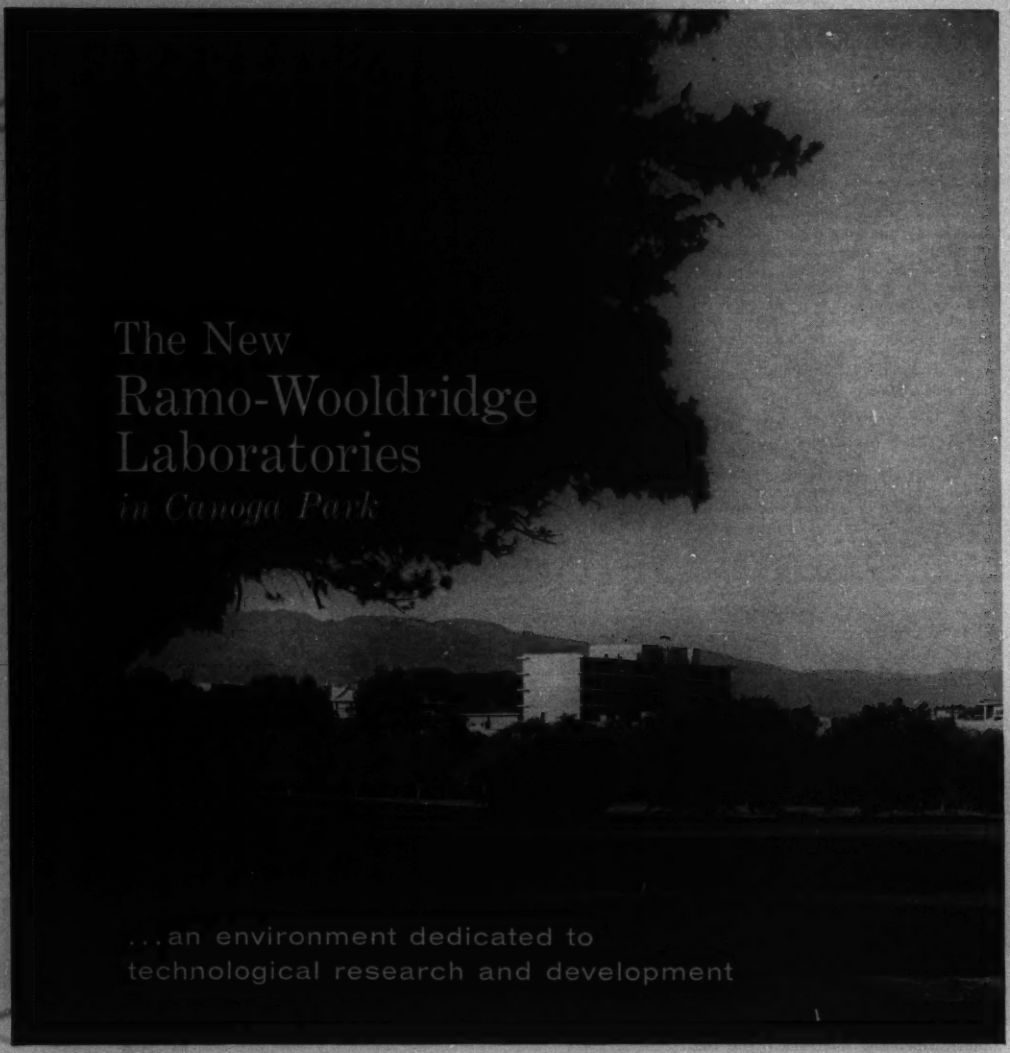
ATOMIC RADIATION (Part II). Covering practical aspects of atomic radiation protection, this new volume discusses such subjects as monitoring techniques and instruments, radiation exposure control, decontamination, radioactive material transport, and waste disposal. Intended primarily as a practical guide for industrial, military, and research installations engaged in nuclear energy activities, the book is equally useful as a text for scientific schools and colleges and for civil defense training. It may be obtained from RCA Service Company, Government Services (210-1), Camden 8, N.Y., at $2.65 per copy.

SIGNAL GENERATOR SPECIFICATIONS. Technical Information Corporation, a clearing house for information on electronic test instruments, has made available a 28-page book containing complete specifications and prices of 152 signal generators manufactured by 30 American and foreign companies. Specifications are arranged in tabular form using common headings. Instruments are arranged according to upper frequency range and run from 70 kc to 40 kmc. All instruments are indexed by manufacturer and function. Copies are available at $2 from Technical Information Corporation, 41 Union Square, New York 3, N.Y.

PATENTS AND INVENTIONS—AN INFORMATION AID FOR INVENTORS. Written for the benefit of the independent inventors and other persons concerned with technological developments and desiring information about patenting and patent procedures, this pamphlet helps in deciding whether to apply for patents, how to obtain patent protection, and how to develop marketing for inventions. Copies of the pamphlet are available through the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C., and the Department of Commerce Field Service Offices in cities where such offices are located at a price of 15¢ per copy.

TECHNICAL MANUAL FOR SUBMINIATURE RATE GYROSCOPES. This new manual opens with a detailed description of basic principles of operation of the subminiature type gyro, then covers operating characteristics, standard types available, transformer pickoff, and use and design of packages of 1-, 2-, and 3-axis sensors for rate acceleration. General application information and operating principles presented are for design use in such applications as fire control systems, autopilots, missile homing, navigation, and instrumentation. A 20-page appendix discusses factors affecting gyro performance, gives sample specifications to aid the engineer in procurement for a diversity of applications, and includes a complete glossary of gyro technology. It is available from Product Manager, Subminiature Rate Gyros, Sanders Associates, Inc., 95 Canal St., Nashua, N.H., $2 per copy.

SELECTED DATA ON URANIUM ALLOYS. This is a compendium of current and recently published information on certain phases of nuclear energy development, particularly of value to designers, metallurgists, chemists, mechanical or other engineers interested in the application of nuclear energy. It is richly detailed and illustrated, containing a bibliography of 470 references alphabetically arranged by authors' names. The book has binary phase diagrams of 27 alloys, and a dozen or more tables and graphs showing the behavior of some uranium alloys under conditions of corrosion and irradiation. It is available for $1 from Sylvania-Corning Nuclear Corporation, Bayside, L.I., N.Y.



The new Ramo-Wooldridge Laboratories in Canoga Park, California, will provide an excellent environment for scientists and engineers engaged in technological research and development. Because of the high degree of scientific and engineering effort involved in Ramo-Wooldridge programs, technically trained people are assigned a more dominant role in the management of the organization than is customary.

The ninety-acre landscaped site, with modern buildings grouped around a central mall, contributes to the academic environment necessary for creative work. The new Laboratories will be the West Coast headquarters of Thompson Ramo Wooldridge Inc. as well as house the Ramo-Wooldridge division of TRW.

The Ramo-Wooldridge Laboratories are engaged in the broad fields of electronic systems technology, computers, and data processing. Outstanding opportunities exist for scientists and engineers.

For specific information on current openings write to Mr. D. L. Pyke.

THE RAMO-WOOLDRIDGE LABORATORIES

8433 FALLBROOK AVENUE, CANOGA PARK, CALIFORNIA

New and Improved Products . . .

Conductive Transparent Coatings . . .

Electrically conductive transparent coating by vacuum deposition of materials will find ready application to defogging windows of aircraft, railroad cars, automobiles, and other installations where a heated transparent surface is desirable. The coatings are normally sandwiched between plastic or glass plates for protection and durability. Typical properties include 75% transmission of light, resistance of 15 ohms over the entire area, and stability between —50 F and 200 F. **National Research Corp., 70 Memorial Dr., Cambridge, Mass.**

Self-Sticking Markers . . .

Eighty-eight self-sticking markers are available in three different sizes to give electrical, plant, or maintenance engineers a ready-made method for identifying each piece of equipment, apparatus, and duct in an electrical service system. The legends are printed on Vinyl cloth and are protected with a durable overcoating. **W. H. Brady Co., 727 K. Glendale Ave., Milwaukee 9, Wis.**

Coated Transformer Covers . . .

Covers coated with Levroc, a thermoplastic cellulose material which has a dielectric strength of 800 volts per mil of thickness, are now furnished with this line of bushing transformers. Insulating the cover, clips, bushing clamps, and haudhole cover with this material eliminates outages caused by wildlife contacting the high-voltage terminals. In addition, its excellent outdoor durability provides protection to the metal parts. **Line Material Industries, Milwaukee 1, Wis.**

Morse Code Converter . . .

With this device, Morse code can be copied and converted into teleprinter code at the rate of from 10 to 120 words per minute. Operating unattended, the converter adjusts automatically to changes in speed of transmission, successfully demodulates noisy signals, and maintains the associated communications receiver tuned to within 5 cycles of the signal being received. Basically a digital computer, the instrument contains 1,752 semiconductors and a 1-inch CRT, the only vacuum tube in the circuit. **CGS Laboratories, Rt. 7 at 35, Ridgefield, Conn.**

Cockpit Radio Control . . .

Today's high performance aircraft requires operation of six radio functions. With this control, a pilot can select communications, TACAN, ILS, Data Link, IFF air-to-air, or IFF air-to-ground by touch

operation of a key on the panelboard. This information is stored in the switching unit until the "actuate" key is pressed. Simplicity, reduction of in-flight controls, less space requirements, and a uniformity of operation are some of the advantages to be gained with this equipment. **Bendix Aviation Corp., Radio Div., Baltimore 4, Md.**

Flame Retardant Connectors . . .

These rigid connectors withstand higher temperatures and can resist fire from arcing that frequently occurs in high-voltage use. Made of Grex, a high-density polyethlyene, this complete range of high-voltage electrical connectors and tube caps can be used in applications previously prohibited by Underwriters' Laboratories, Inc. **W. R. Grace & Co., Polymer Chemicals Div., 225 Allwood Rd., Clifton, N.J.**

Simplified Computer Console . . .

This console will enable anyone to operate a computer because the controls, commands, and data displays are in a language understandable to all laymen. Through the use of a simple keyboard arrangement, the operator may control the computer, to which the console is attached, and demand a display of data either in graphic or understandable printed form on the console's video screen. Bank loan officers will have rapid access to all data for a complete credit check. Staff members will be able to use computers for stock market analysis, sales forecasting, production scheduling, and the like. The console may be connected to any data processing system. **Ramo-Wooldridge, P.O. Box 90534 Airport Station, Los Angeles 45, Calif.**

Printed Circuit Relays . . .

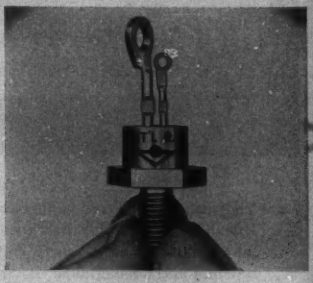
A new development in printed circuit relays consists of an assembly which permits single or multiple installation of mercury-wetted contact relays in the small space of a printed circuit board. The individual switch capsules and coils are affixed to the printed circuit board and sealed from dust, moisture, and tampering by the application of a tough vinyl coating. Customers' printed circuit boards may be adapted to include either the standard HG mercury-wetted contact relay, or the ultra-high-speed HGS, as well as other selected components. **C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Ill.**

Long-Life Thermocouple . . .

This thermocouple has been designed primarily for direct immersion in molten aluminum, magnesium, and lead. The protecting tube consists of a length of reinforced Fiberfrax (registered trade mark) base material usable up to 2,200 F which exhibits the strength of metal and corrosion resistance said to be superior to that of any known ceramic tube. The material is not wetted by molten aluminum and cannot contaminate critical melts with iron or other foreign impurities. **Pyrometer Co. of America, Inc., Penndel, Pa.**

Silicon Controlled Rectifier . . .

This three-junction semiconductor will switch rapidly to a conducting state either when a signal is applied to its third terminal, or when its critical breakover



voltage is exceeded. Thus, it is capable of performing many of the functions of a magnetic amplifier, thyratron, or power transistor. The units are capable of controlling 16 amperes of current for static switching, d-c motor controls, ignition firing, and similar switching uses, or for blocking voltages from 20 to 200 volts. **International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif.**

(Continued on page 20A)

Popular, small Model VT2 (with overvoltage). Volts output: 0-120/132; amps output: 1.5 . . . Model VT2N (without overvoltage). Volts output: 0-120; amps output: 1.8. This model delivers more current than existing transformers of comparable size and price.

Models VT4 and VT4N provide output capacity greater than other units of comparable size and price. Model VT4 (with overvoltage). Volts output: 0-120/140; amps output 3.5 . . . Model VT4N (without overvoltage). Volts output: 0-120; amps output: 4.75.

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VARIABLE TRANSFORMERS

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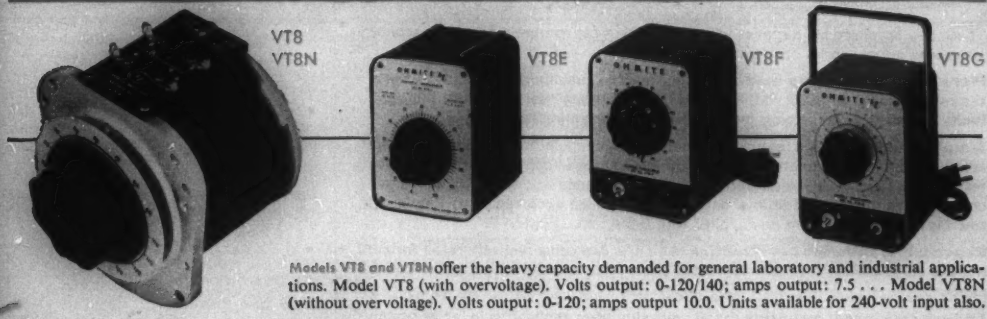

Models VT8 and VT8N offer the heavy capacity demanded for general laboratory and industrial applications. Model VT8 (with overvoltage). Volts output: 0-120/140; amps output: 7.5 . . . Model VT8N (without overvoltage). Volts output: 0-120; amps output 10.0. Units available for 240-volt input also.

Now you can get *fast delivery from stock* on 35 different models of Ohmite variable transformers. This newly expanded selection covers a high percentage of industrial needs. In it you will find single and three-phase units, two and three-in-tandem assemblies (not shown above), plus a variety of other cased and uncased models.

Ohmite "v.t." variable transformers combine fresh thinking in design with traditional Ohmite quality. For example, positive current transfer is achieved with direct brush to slip-ring, pig-tailed connection. Adjustable shafts on sizes VT4 and VT8 extend either to the brush or the base side. These two models also are *interchangeable* with competitive makes of comparable ratings. The "N" types in all three models provide additional current without overvoltage. The next time you need variable transformers, select from the line with advanced design—Ohmite.

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These new Sorensen MD supplies form one of the most comprehensive and economical power supply series on the market.

More than 130 catalog models to choose from, providing 20 output voltages in the range from 3 to 1000 vdc, inclusive. Sorensen engineers welcome the opportunity to develop non-catalog models for unusual requirements.

Simple, rugged design features magnetic voltage regulator to obtain ±1% regulation against input line variations plus low-impedance silicon rectifier for good load regulation. (Typical regulation from 50% load to full load is 2% to 10%, depending on load current rating. Additional data can be supplied upon request.) Ripple: 1% rms max. (Some units can be supplied with 0.5% max. ripple.)

Dependable, tubeless construction. All parts are conservatively rated for continuous duty. Units will withstand output short circuits without damage to components.

19-inch rack-panel mounting for all units simplifies application in lab or custom-built equipment.

Rugged MD series supplies are just one example of the outstanding power-supply models offered by Sorensen. **Sorensen controlled power equipment, with the widest line, enables you to make the wisest selection.** Included are: regulated d-c supplies, regulated a-c supplies, variable frequency power sources (frequency changers; for example, 60 to 400 cps), high voltage supplies (to 600 kv, ac or dc), and miniature converters and inverters. Available in an extremely wide variety of input-output combinations. Write for complete specs. Sorensen & Company, Richards Ave., South Norwalk, Conn. 0.48

*Voltage range, these sizes: 6.3 to 1000 vdc

**Voltage range, this size: 12 to 1000 vdc

Sorensen

A subsidiary of Raytheon Company

CONTROLLED POWER PRODUCTS

...the widest line lets you make the wisest choice

New & Improved Products

(Continued from page 18A)

"Hermaphrodite" Electrical Connector . . .

The main feature of this connector is that each length of cable is both a plug and a socket. The immediate need for these is in highly mobile military communications and power equipment. The new

connectors have a power rating of up to 100 amperes, 440 volts a-c, and are suitable for 2- 3- or 4-wire cables. **Specialty Electronics Development Corp., Syosset, N.Y.**

Automatic Insulation Tester . . .

Fifty test samples of transformers, motors, capacitors, cables, bushings, switchgear, and other electrical equipment can be subjected simultaneously to high-voltage breakdown tests for unattended periods up to 12 hours with this apparatus. Individual components or circuits connected to it are automatically tested in sequence at a preset potential. When a breakdown or leakage occurs in excess of a predetermined value, the device may sound an alarm, shut off completely, or continue checking the balance of the units. In addition, the test potential will drop to zero on the unit that has failed. **Associated Research, Inc., 3777 W. Belmont Ave., Chicago 18, Ill.**

Nonreproducible Blue Line Paper . . .

Transblue *200 T* is a translucent, dry-developed diazo paper coated with a light blue line sensitization which is not reproducible on other diazotype materials. The blue line serves only as a legible guide and does not obstruct actinic light and therefore will not reproduce. Transblue is especially well-suited for color separation, visual aid materials, geological maps, medical training charts, designing wiring diagrams, and lifting out details from assembly drawings. Line drawings can be made from photographic copy by printing the negative on Transblue and using the outlines of the negative image for guides. **General Aniline and Film Corp., Ozalid Div., Johnson City, N.Y.**

(Continued on page 22A)

One of a series

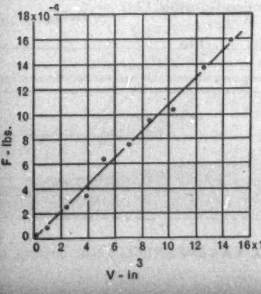
On the riddle of rolling friction

It doesn't take much to roll a hard ball across a hard, smooth, level surface — actually only about 0.00001 times the normal force acting vertically on the ball. But by careful measurement of this tiny rolling force, scientists at the General Motors Research Laboratories are helping to unravel the riddle of rolling friction.

An important relationship recently uncovered in this fundamental study: the rolling force is proportional to the volume of material that is stressed above a certain level. As a result, a GM Research group have not only confirmed the hypothesis of *how* a rolling ball loses energy (Answer: elastic hysteresis) but also have learned *where* this lost energy is dissipated (Answer: in the interior of the material, not on the surface). Mathematical analyses have indicated the exact shape of the elastically stressed volume in which all the significant frictional loss takes place.

The purpose of friction research at the GM Research Laboratories is to learn more about the elastic and inelastic behavior of materials. This knowledge — of academic interest now — will eventually give GM engineers greater control of energy lost through friction. This is but one more example of how General Motors lives up to its promise of "More and better things for more people."

General Motors Research Laboratories
Warren, Michigan



Relationship of rolling force to elastically stressed volume.

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New & Improved Products

(Continued from page 20A)

Miniature Data Printer . . .

A data printer that is smaller than a pack of cigarettes and weighs only a few ounces has been developed in the Research Division of New York University. Because the printer requires very little operating power, recordings can be made directly from the output of most electronic devices, thus eliminating the usual isolation and driver stages. Printing is accomplished by energizing the appropriate elements of an array of stainless steel printing segments. The device can print as many as 20 digits simultaneously. **New York University, College of Engineering, New York 53, N.Y.**

Built-In Battery Charger . . .

Here is a battery charger that is built directly into the battery container. The new *AR-2* silicon rectifier charger will recharge a 6-cell, 12-volt motive power battery overnight. Available in two different size battery combinations for trucks with integral battery compartments, the unit plugs into any standard 15-ampere, 115-volt, 60-cycle convenience outlet and is completely automatic in operation. **The Electric Autolite Co., C & D Batteries, Div., Conshohocken, Pa.**

Sealed-In Motor . . .

The lubricating oil is sealed inside the turning-rotor of this fractional horsepower electric motor, thereby cutting oil oxidation to a minimum. The result is that the *S/L 1085* should run continuously for 10 years or more without attention. Quiet in

operation, the motor is applicable to many industrial and domestic uses such as circulating air inside home and display freezers, cooling electronic data machines, driving small exhaust fans, and cooling larger motors. **Howard Industries, 1760 State St., Racine, Wis.**

(Continued on page 25A)

New & Improved Products

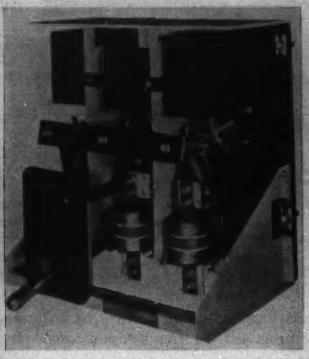
(Continued from page 22A)

Open Cutouts . . .

A completely new line of 100-ampere open cutouts extends overcurrent protection to a range previously unattainable. These cutouts have voltage ratings of 7.8, 15, and 27 kv and feature exceptionally high interrupting ratings of 20,000, 16,000, and 6,000 amperes, respectively. Test-proven LMO cutouts afford superior fault-current protection to distribution systems with voltages of 7,200 volts delta through 14,400/24,900 volts grounded wye. **Line Material Industries, Milwaukee 1, Wis.**

Circuit Protector . . .

The Fusematic is a 600-volt co-ordinated fuse-breaker unit that offers fault-circuit protection at a substantially lower cost than if a conventional breaker alone were used. Combining components of conventional low-voltage power circuit



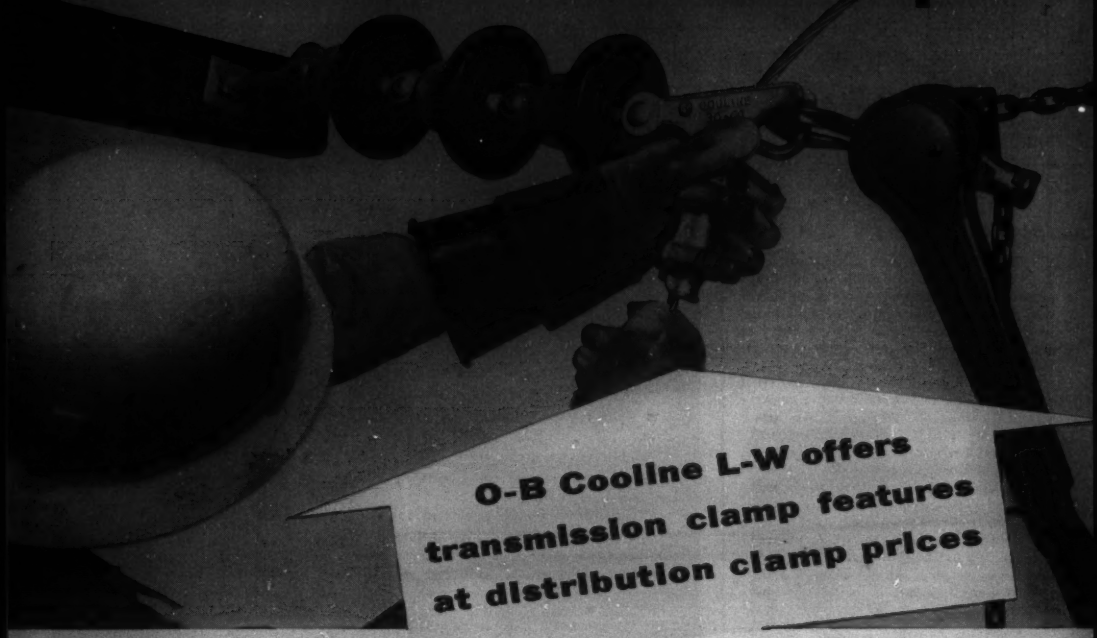
breakers and current-limiting fuses, the apparatus is rated up to 1,600 amperes continuous and 200,000 amperes interrupting capacity. Its primary application is for service entrance and feeder protection where high fault current exists. **Federal Pacific Electric Co., 50 Paris St., Newark 1, N.J.**

Silicone Varnish . . .

An all-new Class *H* silicone dipping and impregnating varnish that is as easy to process as most Class *A* and *B* varnishes, cures in only 6 hours at 150 C. Despite its low curing temperature, this varnish meets AIEE requirements for use in 220 C systems and will make it possible for original equipment manufacturers and service shops to produce Class *H* units or production equipment designed for Class *A* and *B* equipment. **Dow Corning Corp., Midland, Mich.**

(Continued on page 27A)

A real bargain in distribution clamps!



O-B Cooline L-W offers transmission clamp features at distribution clamp prices

You can build transmission-grade construction into distribution deadends when you use the low-cost, aluminum Cooline L-W clamp.

The O-B Cooline L-W is especially designed for the distribution trend to larger conductors and shorter spans, but it offers many of the advantages of the heavy-duty Cooline series for transmission lines. The L-W has:

Excellent Holding Strength -- More than adequate for distribution deadends -- 10,000 pounds for two U-bolt clamps, 15,000 pounds for three U-bolt model.

Aluminum Construction -- Minimizes electric losses and conductor heating.

No Need to Cut Conductor -- Conductor can be strung in continuous loop without cutting or splicing. It automatically comes off at the proper angle for making the jumper loop.

Protection for Conductor -- Wavy seat of clamp and special contour of captive keepers develop firm holding action without crushing conductor.

Wide range of conductor sizes (.20 to 1.3 inches diameter), light weight, standard packaging for easy handling and inventory, and simple installation are among the many benefits of this versatile clamp.

You get all this in the Cooline L-W at a price that will surprise you -- pleasantly. Check the L-W and you'll find it's today's real bargain in distribution deadend clamps.

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BUSHINGS • HOLAN TRUCK-MOUNTED POWER DEVICES AND BODIES • BRONZE VALVES

4953-H

New & Improved Products

(*Continued from page 25A*)

Single Image Video Recorder . . .

At the touch of a button, this device will instantly store a single frame of a television picture for immediate recall and prolonged study. Using an electrostatic storage tube, the apparatus will be useful in displaying one moment in a televised sporting event, or a nonrecurring military or commercial test. It will also be useful as a means of displaying high-speed motion illuminated by a flash lamp. Input and read-out is a composite video of standard amplitude and polarity. A single frame of input is sufficient to obtain a full contrast stored picture. **Image Instruments, Inc., 2300 Washington St., Newton Lower Falls 62, Mass.**

Shuntless Tilting Insulator Switch . . .

This shuntless tilting insulator switch called type *TRS* is available in voltage ratings of 7.5 to 23 kv and continuous current ratings of 400 to 600 amperes. Switches rated at 400 amperes have a momentary rating of 20,000 amperes while those rated at 600 have a momentary rating of 40,000 amperes. A reversed-loop type of contact has been incorporated in this switch for the first time, thereby providing more than adequate capacity for handling short-circuit currents for which it is rated. **Southern States Equipment Corp., Hampton, Ga.**

Time Delay Switch . . .

Weighing less than 3 ounces, this new solid-state time delay switch is capable of handling up to 50 amperes without arcing, contact damage, radio interference, audible noise, or vibration. Voltage ratings are 24-31 volts d-c and all parts are hermetically sealed. **George Harmon Co., Inc. Northridge, Calif.**

Electronic Sensing Control . . .

Extensively redesigned, this new control recognizes metallic or nonmetallic objects without physical contact as they enter a capacity field. For use where switches are impractical, the Model *400* consists of a sensing element connected by coaxial cable to the electronic control. Not only does the unit recognize errors or deviations from the constant as objects enter the field, but it indicates whether the sensed objects are too large or small, or too near to a predetermined setting. Applications include detecting variations in material flow, moisture content, presence of foreign substances in fluids, detecting undesireable areas in continuous strip materials, and many other sensing operations. **Security Controls, Inc., 503 Franklin St., Buffalo 2, N.Y.**

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Other things are also important. The people at Nelson are interested in seeing that you have the very best workmanship. Nelson engineers with their long experience in motor control will see that your job is built to do exactly what you want it to do. Cooperative team work is more than a phrase at Nelson.

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Expanding a capability . . .

Raytheon's Airborne Electronic Subdivision this month occupies a new multi-million dollar research and development laboratory.

Creative effort within this new facility will be directed at featherweight transistorized Doppler radars; altimetry and terrain clearance techniques; satellite weather radar studies; airborne early warning radars; missile boost, flight and terminal guidance problems; radiometry; and other areas.

Like the B-58's sophisticated search and Doppler radars, the systems, subsystems or equipments developed will find application in manned aircraft, missiles, drones, and a variety of space carriers.

To engineers and scientists with particular interest in this work, the new laboratory offers complete professional satisfaction in an academic environment. For immediate information on select staff appointments, write Mr. Donald H. Sweet, Engineering & Executive Placement, Raytheon, 624 R Worcester Road, Framingham, Mass. (suburban Boston).

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Industrial Notes...

Martin Nuclear Division Baltimore, Md. . .

A bundle of metal tubes small enough to fit inside the trunk of a car will contain 2 years' supply of fuel for one of the first nuclear power plants, designated *PM-1*, to be installed at an operational U. S. Air Force station at Sundance, Wyo. Heat supplied by nuclear fission inside the tubular fuel elements will be transmitted to water flowing under pressure through and around the tubes. A heat exchanger will transfer the heat to a secondary system, in which water at normal pressure will be turned into steam to drive a conventional-type turbine generator. The entire plant, including the generating equipment, is being designed by Martin Nuclear Division, Baltimore 3, Md., under contract to the U. S. Atomic Energy Commission, in a series of factory-assembled "packages" which can be interconnected at the Wyoming site.

Motorola Inc. Chicago, Ill. . .

The U. S. Weather Bureau is installing a 10-mile microwave system to transmit data between computer stations at the National Bureau of Standards (NBS) in Washington, D. C., and the Weather Bureau's National Meteorological Center in suburban Suitland, Md., provided by Motorola Inc., 4501 W. Augusta Blvd., Chicago 51, Ill., the system will take information from a magnetic tape at one station and record it on a similar tape at the receiving station. The tape can then be used as input for the IBM *704* computers used at both stations. The transmitted information will consist of official weather reports assembled at Suitland. These reports will be processed by the NBS computers and the results will be transmitted back to the Suitland station. Computers at both locations are used because of a heavy work load and the need for standby facilities.

Consolidated Electrodynamics Pasadena, Calif. . .

A magnetic tape recorder/reproducer built by the DataTape Division of Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif., has been delivered to the National Aeronautics and Space Administration to record telemetered data from Project Mercury, the nation's first manned orbital space flight.

(*Continued on page 34A*)

Field rings were breaking brushes!

NATIONAL TRADE-MARK **stopped brush breakage!**

DOWN-TIME COULD HAVE COST THIS POWER COMPANY A FORTUNE!

"RED" BLACKBURN

PROBLEM: Threading and grooving of the steel field rings on giant turbine generators.

RECOMMENDATION: "National" brush grade 634.

RESULTS: This brush eliminated threading, grooving and resisted breakage and chipping when applied to eccentric rings.

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Compact portable set is housed in shock and wear resistant case for severe field use in testing reconditioned equipment after installation, as well as for preventive maintenance of installed equipment. Also available in a bench model for making acceptance and proof test on electrical insulating systems for quality control in manufacturing and repair. For complete description, specifications and prices, WRITE FOR BULLETIN 22-5-EE.

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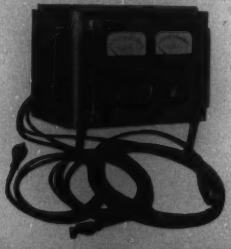

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Industrial Notes

(Continued from page 32A)

Sperry Gyroscope Co.
Great Neck, N. Y. . .

A completely transistorized fire control instrument that will control the latest type of antisubmarine warfare torpedo, is under development at the Sperry Gyroscope Co., Division of Sperry Rand Corp., Great Neck, N. Y. Called the *Mark 18* angle solver, this instrument is being developed by Sperry for the U. S. Navy Bureau of Naval Weapons under subcontract to Westinghouse Electric Corp., Baltimore, Md.

Bailey Meter Co.
Cleveland, Ohio . . .

U. S. Steel Corp., Fairless Works, has purchased a digital data system to monitor and log temperatures on 16 soaking pit recuperators. The Metrotype Information System, as it is known, is being engineered and manufactured by Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland, Ohio. Monitoring is to be continuous, with a typewritten log of all temperatures made at regular intervals, and upon detection of any off-normal temperature. Of prime importance to U. S. Steel in selecting a digital data system for this service was a saving of panel space and a reduction of time required for routine operations.

Philips Electronic Instruments
Mt. Vernon, N. Y. . .

The 35th Norelco X-ray School will be devoted entirely to the subject of X-ray spectrography, according to Philips Electronic Instruments, 750 S. Fulton Ave., Mount Vernon, N.Y. Sessions will be held at the Henry Hudson Hotel, 353 W. 57th St., New York City, during the week of February 15—19, 1960. Registration for the course is open to chemists, metallurgists, physicists, production supervisors, quality control engineers, and others interested in the applications of X-ray spectrography.

IBM
White Plains, N. Y. . .

Philadelphia has joined the major cities where powerful International Business Machines Corp. (IBM) computers will be available to businesses by the hour. A Datacenter will be operating in the metropolitan area by the middle of 1960 as the latest in a series of similar installations planned across the nation. They represent a radical departure from IBM's traditional monthly leasing policy for data-processing equipment. IBM Datacenter users will supply their own programmers and their own operators. IBM, Data Processing Division, 112 E. Post Rd., White Plains, N. Y.

(Continued on page 36A)

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Lower, lighter up to 40%!
For use anywhere in your system

1. Electrical resettable drag hands on position indicator, reset from push button in control panel.
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4. Easily read, six-digit, direct-reading counter records JFR's life history to one million operations.

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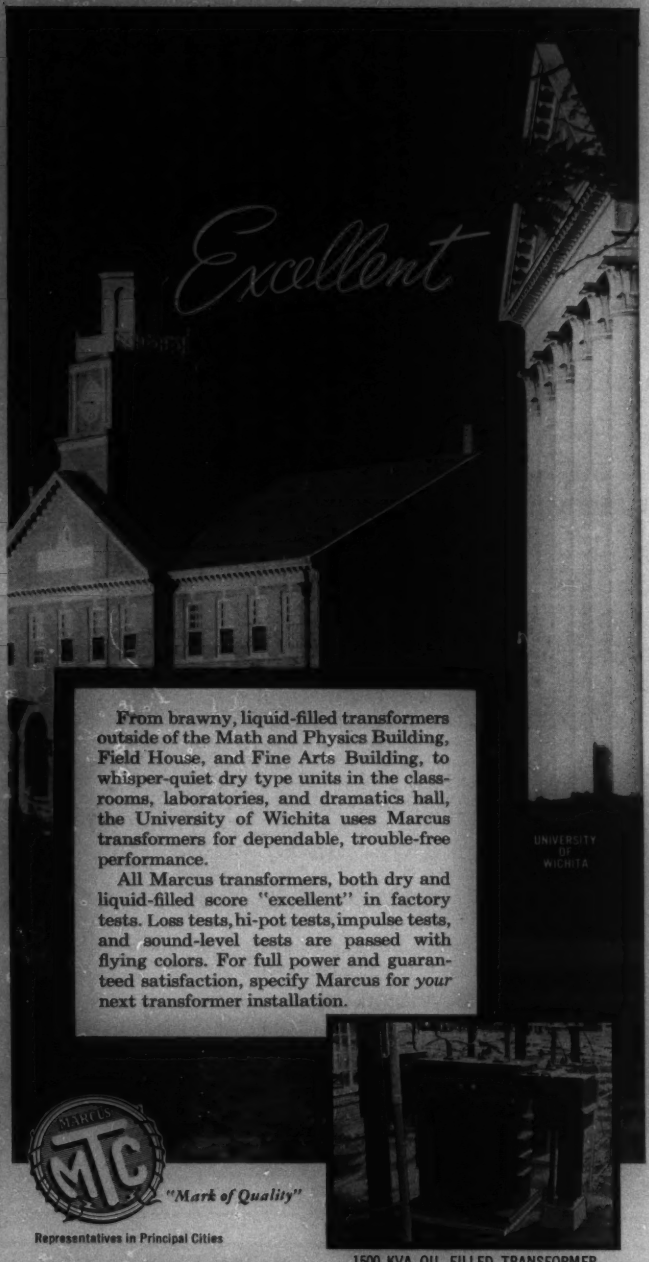

From brawny, liquid-filled transformers outside of the Math and Physics Building, Field House, and Fine Arts Building, to whisper-quiet dry type units in the classrooms, laboratories, and dramatics hall, the University of Wichita uses Marcus transformers for dependable, trouble-free performance.

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Industrial Notes

(*Continued from page 34A*)

Miniature Precision Bearings, Inc. Keene, N. H. . .

A new western technical center and sales office has been opened by Miniature Precision Bearings, Inc. at 8621 S. Bellanca Ave., Los Angeles 45, Calif. The new center is to provide greatly expanded engineering services for customers in the western region. A fully equipped bearing test and evaluation laboratory, called the White Room is so finely air conditioned that particles larger than 0.3 microns are filtered out. The expanded engineering services will include special engineering assistance to design and application engineers, as well as to all people engaged in the selection, purchase, handling, and evaluation of miniature and instrument ball bearings. The facility will be supplied with a complete bearing inventory allowing for 24-hour delivery of prototype bearings.

Ampex Corp. Redwood City, Calif. . .

Ampex Corp., 934 Charter St., Redwood City, Calif., will henceforth be conducting its domestic business through five integrated companies as part of a policy to decentralize and integrate operations along market or product centered lines. Ampex Data Products Co., with an Instrumentation Products Division and Computer Products Division, manufactures equipment for industry, business, space technology, defense requirements, and scientific research. Ampex Professional Products Co., with the Video Division and Audio Division, produces professional equipment for the television, radio broadcasting and recording industries. Ampex Military Products concentrates on research and development work for the U. S. Government and Government prime contractors. Ampex Audio, Inc., manufactures complete stereophonic systems and related consumer products for the hi-fidelity market. Orr Industries, manufacturer of magnetic tape for instrumentation, computer, video, and audio applications, was acquired by Ampex in a recent merger.

Hamilton Standard Broad Brook, Conn. . .

A complete printed circuit facility has been formed in the Electronics Department of Hamilton Standard, division of United Aircraft Corp. Printed circuits are used in a number of the company's electronic systems and are particularly important in the department's flight and propeller controls. In addition, under the department's autonomous structure, printed circuits may be developed for other customers outside the company.

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DID YOU KNOW THESE FACTS ABOUT ROSEAL . . .
Rome's flame-retardant polyethylene jacketing compound?

1. Roseal is a non-metallic flame-retardant polyethylene compound used primarily as a jacket.
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Explains and illustrates applications, advantages, limitations of 24 different test methods applicable in every branch of engineering and industry. Specifications, equipment costs, hundreds of pages of test interpretation data. *Prepared under the auspices of the Society for Nondestructive Testing. 1,100 illustrations, graphs, tables; 1,910 pp. 106 Contributing, Consulting Editors. Robert C. McMaster, Ed. October, 1959.* 2 volumes, $24

PRODUCTION HANDBOOK

Packed with practical production know-how, this Handbook is the complete key to management-engineering methods that are revolutionizing industrial production today. Fully covers new materials, machines, processes, and proper functioning of company organization.

Supplies proved principles, time- and work-saving systems, and successful operating procedures for maximum productivity at minimum cost. Saves hours of research and costly experimentation. *726 illustrations, tables; 1,726 pp. 48 Contributing, Consulting Editors. Gordon B. Carson, Ed. 2nd Ed., 1958.* $16

MATERIALS HANDLING HANDBOOK

The complete guide to modern materials handling. This unique Handbook explains the governing principles, today's most efficient methods and systems, and recommended equipment for moving material at least cost — whether in raw, in-process, or finished form.

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Trade Literature...

Master Time and Program Signalling Systems . . .

This 20-page catalog, published for the information of electrical engineers, architects, and maintenance personnel, describes Master time and program controls and secondary indicating clocks for both minute impulse and wired synchronous systems, as well as audible signaling equipment, including bells, horns, and chimes. **Cincinnati Time Recorder Co., 1733 Central Ave., Cincinnati 14, Ohio.**

Data-Processing Literature . . .

Features, specifications, and applications of the Model *201* high-speed digital plotter, the Model *150* tape preparation and editing console, and logic switches are available in three brochures from **Tally Register Corp., 5300 14th Ave., N. W., Seattle 7, Wash.**

Fuel Burning Equipment Catalog . . .

A 12-page, illustrated catalog shows a complete line of commercial and industrial fuel burning and auxiliary equipment; it has a particularly helpful Index and Selection Chart which simplifies selection of appropriate equipment for any application. The entire Iron Fireman commercial-industrial line of oil burners, gas burners, dual-fuel burners for gas and oil, forced draft package units, boiler-burner units, coal stokers, factory wired combustion control panels, and the SelecTemp steam heating system is covered. Form 6260 is available from **Iron Fireman Manufacturing Co., 3170 W. 106th St., Cleveland 11, Ohio.**

Engineering Catalog . . .

This fully illustrated catalog is a general compilation of information on important aspects of electrical contact theory and practice to lend considerable assistance to the design engineer. Typical sections of the engineering catalog include engineering services and facilities, electrical contact phenomena, design factors, selection, classification, and properties of contact materials, specific engineering data on Brainin Co. precious metals and their alloys, contact backing materials, composite and laminated materials, and many other factors applicable to many contact design problems. Write on company letterhead to **C. S. Brainin Co., 320 Washington St., Mt. Vernon, N.Y.**

(Continued on page 40A)

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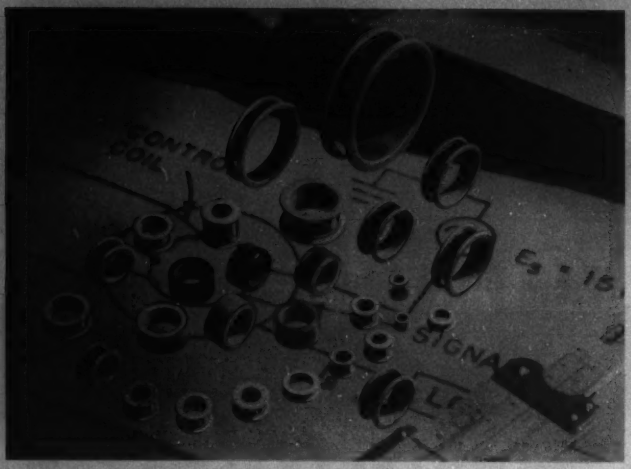

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Write for Bulletin TC-108A "Tape-Wound Bobbin Cores for Computer Applications." Includes data on applications and properties, fabrication and testing of Arnold Bobbin Cores; lists standard sizes, etc.

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Trade Literature

(Continued from page 38A)

Trimming Potentiometer Test Data . . .

A certified test report of particular interest to engineers with trimming potentiometer applications, describes the Series *50* Helitrim trimming potentiometer, a highly stable ceramic/metal unit produced in quantity by Helipot. **Helipot Technical Information Service, 2500 Fullerton Rd., Fullerton, Calif.**

Chemical Product Catalog . . .

A 36-page product catalog and directory lists specifications, end-uses, and other technical data for the more than 1,000 products manufactured and distributed throughout the world by The Borden Chemical Co. Industrial and consumer products are reviewed in the general areas of basic chemicals, monomers, polymers, resins, adhesives, coating materials, plastic products, fine chemicals, organic intermediates, and biochemical reagents. **Write Department H, The Borden Chemical Co. 350 Madison Ave., New York 17, N. Y.**

Instrument Catalog . . .

This 36-page, 1960 catalog describes a complete line of equipment which measures the electrical characteristics of control synchros, torque synchros, and computing resolvers. The theory of operation, operating procedure, and specifications for each item of equipment are described in detail. **Theta Instrument Corp., 520 Victor St. Saddle Brook, N. J.**

Switch and Terminal Catalog . . .

The completely revised 24-page catalog of switches and quick-connect terminals gives detailed information on the expanded product line. Comprehensive data on multicircuit push-button switches and the new multicircuit stack switches have been added to the information on range-heater, motor-reversing, toggle, and slide switches. The catalog gives details of handles, hardware, shaft styles, and terminals and includes dimension drawings, wiring diagrams, circuit sequences, and electrical ratings for each switch listed. **ARK-LES Switch Corp., 51 Water St., Watertown 72, Mass.**

Capacitor Bulletin . . .

With the addition of a new larger case size, type *109D* tubular sintered-anode Tantalex (registered trade mark) capacitors are now available in capacitance ratings ranging from 560 μf, 6 volts to 43 μf, 100 volts in the Group 2 ± 20% tolerance units and from 330 μf, 6 volts to 30 μf, 100 volts in the Group 1 units. The complete story on Type *109D* capacitors is given in Engineering Bulletin 3700D. **Sprague Electric Co., North Adams, Mass.**